SCHOOL SCIENCE AND MATHEMATICS

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THE FIFTY-SECOND ANNUAL PARADE OF SCIENCE AND MATHEMATICS

There are only a few more days until November 28 and 29 when you will see a unified structure which has resulted from the cooperative effort of over 200 staunch and tireless members of Central Association of Science and Mathematics Teachers. Many other members who did not have direct responsibilities contributed valuable ideas and suggestions. Central Association is to be congratulated on a membership of active participants. You will soon receive a complete copy of our annual program in the *Yearbook*.

Dr. Raymond Kienholz, Professor of Forestry at the University of Connecticut, will be our banquet speaker. His lecture will be of interest to young and old, scientists and laymen.

Other topics to be discussed which appear on the program and were not listed in the October issue of SCHOOL SCIENCE AND MATHEMATICS are:

1. Human Conservation
2. Psychological Considerations in the Learning of Arithmetic
3. Great Lakes—How They Were Formed
4. The Atom and You.

These topics will be handled by top-notch people, some of whom are:

Mr. James Sanders, Chicago Teachers College
Miss Charlotte Junge, Wayne University
Mr. F. Lynwood Wren, Peabody College
Mr. Warren McGonnagle, Argonne National Laboratories.

These people and others are giving freely of their time and energy to share their ideas with us. Time has also been provided on the program for discussion periods. Your contributions to these discussions will be appreciated.

We shall be looking forward to meeting you at the Edgewater

Beach Hotel on November 28. Make your reservations with:

Reservations Manager
Edgewater Beach Hotel
Chicago 40, Illinois

Bring your friends and enjoy the companionship and the exchange of ideas with your colleagues.

PHILIP PEAK, *President*

CHANGES IN THE PHYSICS DEPARTMENT

Mr. E. Wayne Gross of The University School of Indiana University is our new editor in charge of high school physics. Mr. Gross began his teaching career in 1940 at Strawn, Illinois after receiving his bachelor's degree from Illinois State Normal University at Normal. After two years at Strawn he transferred to the science department at Blue Mound, Illinois and continued his education at Normal during the summers. He completed his work for the master's degree in 1946 and in the fall went to the University School of Indiana University as instructor of the physical sciences and critic teacher in science. He is a member of Phi Delta Kappa, the N.E.A., the Indiana State Teachers Association, the Physics and Chemistry Teacher Association of Indiana, and the Indiana Academy of Science. During the present year he is on leave of absence from teaching to work toward the doctorate degree and to continue work on the series of science books with Ira C. Davis and John Burnett. The ninth grade book in this series was reviewed last month by our Mr. Miller. Mr. Gross was married in 1946 to Miss Lucile Copeland of Farmer City, Illinois. In addition to his work as a teacher and text book writer he finds time for recreation in photography, wood work, gardening and chicken raising. He is also a member of the Masonic Lodge. All this should insure his success as editor of high school physics.

Mr. Joseph D. Elder, our former physics research editor resigned because he is no longer in the teaching field. This work will now be done by Julius Sumner Miller, previously in charge of the high school department. Mr. Miller is spending the present year at the University of California at Los Angeles as a Ford Foundation Fellow in the Department of Physics.

Pre-paint auto cleaner "shampoos" the metal before spray painting is begun. The solvent removes films of silicon polish and wax as well as particles of grit and dust, leaving the body ready to be sanded, washed and painted.

THE MERITS AND CONTENT OF A FRESHMAN MATHEMATICS COURSE[1]

F. LYNWOOD WREN
George Peabody College for Teachers, Nashville, Tenn.

A few days ago as my wife and I were reading the morning paper she called my attention to a fill-in news item that read as follows: "A Boston five-and-dime store advertised a filled tool box on sale for $4.98. In small print, the advertisement said the regular price was $4.89." The implications of such an advertisement as that, of course, constitute a serious indictment against the careless reading habits of the American public.

I must confess that I was somewhat guilty of these same careless habits when I first read the topic assigned to me for this discussion. The topic read: "The Merits and Content of a Freshman Mathematics Course Combining College Algebra, Trigonometry, and Analytical Geometry." In the first reading of this topic the word "Freshman" did not take on a great deal of significance. In fact, in my original thinking as to the implications of the topic, it might as well have read: "The Merits and Content of a Mathematics Course Combining College Algebra, Trigonometry, and Analytical Geometry." Indeed it is quite probable that professional lethargy had allowed my thoughts to become steeped in a traditional stupor that caused me to feel that the word "Freshman" was redundant and superfluous in such a title. Maybe the weakness in my thinking was crass stupidity issuing from a sort of Puritanic state of mind that caused me to think along the lines of least conventional resistance. How easy it would be to eulogize the merits and content of trigonometry, analytical geometry, and even of chameleonic college algebra. After all, I have devoted my life and interests to the study and teaching of mathematics. It is only natural that I should take professional pride in extolling the merits of any phase of its content. Furthermore, the protection of tradition offers at all times comforting assurance which can be very alluring; in fact, I sometimes think it has virtually seduced those of us who are interested in the mathematics program in our elementary schools, secondary schools, and junior colleges. When one contemplates the body of literature devoted to the selection and organization of mathematical content designed for instructional purposes at these three educational levels he might very easily imagine that Omar Khayyám had this program of mathematics in mind when he wrote the seventy-sixth quatrain of the Rubáiyát:

[1] An address delivered at the annual meeting of the Central Association of Science and Mathematics Teachers, Junior College Group, Cleveland, Ohio, November 24, 1951.

> The Moving Finger writes; and, having writ,
> Moves on: nor all your Piety nor Wit
> Shall lure it back to cancel half a Line,
> Nor all your Tears wash out a Word of it.

Do not misunderstand me. I am not denying that there is a great deal of good in the traditional mathematics program nor am I lamenting that there has been no progressive spirit in the deliberations of our leaders. I have been making a considered effort, however, to lead your thoughts to the framing of a few questions which I consider extremely pertinent and timely. Have we not reached that point in our educational growth and development where there is urgent need for a careful rethinking of the mathematics curriculum from the first grade through the junior college? Have we not progressed far enough in our study of the philosophy of curriculum construction and the psychology of learning to recognize the possible existence of fundamental weaknesses and harmful obstructions in the present program of mathematical instruction which is basically traditional in nature? Is it not possible that the combined efforts of informed personnel, working in the perspective of the best modern thinking in educational philosophy and psychology, might find that a program with principal emphases on fundamental concepts, basic meanings, significant techniques, characteristic modes of perception and thinking, and aesthetic appreciations, supplemented when desirable by mechanical details, would be far more interesting, challenging, stimulating, and enlightening to the mathematical neophyte than the present program? Is it not too often the case that, in the present program, such values have to be sought by the enlightened and supplied to the uninformed in an effort to restore vitality and freshness to the potentially fertile field of mathematical thought and endeavor which is too frequently rendered sterile and uninteresting through overemphasis on the details of mechanical operations? Is it not true that when the topic for this discussion is contemplated in the perspective of the theme for this sectional meeting the word "Freshman" becomes the most important word in it? The theme for this meeting is: "How Can We Improve Our Beginning Courses?" I submit to you that in the context of this question it is very doubtful indeed as to whether the words "Combining College Algebra, Trigonometry, and Analytical Geometry" should have any place whatsoever in the topic for this particular discussion. In fact, to be honest with my own thoughts I have had to revise the topic to read: "The Merits and Content of a Freshman Mathematics Course." The reason for this stand is not that I hold a brief against the subject matter of college algebra, trigonometry, or analytical geometry. It is that I object to prejudicing our thoughts along any predetermined lines when we are making an

effort to discuss a problem of as much educational significance as the one before us today. Let us not be guilty of soothing our educational conscience by an attitude of resigned acceptance of the furrows of time such as Aunt Het may have used to soothe her romantic conscience when she said: "I reckon it sounds queer to strangers, but I got used to callin' Pa 'Honey' before he looked like he does now."

The Merits of a Freshman Mathematics Course

The twentieth century has seen a great change in the educational pattern of the United States. This change has been nourished in the basic philosophy that: "Education for all is not only democracy's obligation but its necessity." It has not only caused modification of basic points of view as to the function and responsibility of a liberal education, but it has also resulted in more and more people striving to attain higher levels of schooling. The increase in numbers has been almost as spectacular at the junior-college level as it has at the elementary-school and high-school levels. According to the President's Commission on Higher Education there were, in 1900, fewer than 250,000 students enrolled in institutions of higher education; and it is estimated that, in 1960, a minimum of 2,500,000 young people will be enrolled in the junior college alone.[2]

The Commission on Post-War Plans of the National Council of Teachers of Mathematics has said:

> "From the point of view of interest in mathematics, the student body of the junior college will divide itself into three major groups: *Group I*—those students who desire some knowledge of mathematics merely as a part of their cultural background; *Group II*—those students who need a minimum of certain mathematical prerequisites because of their desire to follow specific vocational interests; *Group III*—those students who have major mathematical needs because they plan a career in some field such as engineering, natural science, or pure mathematics."[3]

To these groups there should, of course, be added a fourth one, namely: *Group IV*—those students who, for one reason or another, feel that they have no interest whatsoever in mathematics.

These four groups of students with their wide differential in mathematical interests are merely indicative of a curriculum and instructional problem which should, and does, cause grave concern in educational circles. Not only does there exist a wide differential of interest in mathematics among junior-college students, but there will be equivalent differentials of interest in many other areas of learning. The President's Commission has given expression in the following words to the magnitude of the problem which this situation creates:

[2] President's Commission on Higher Education, Report of; Vol. I, *Establishing the Goals* (Washington, D. C.: Government Printing Office, 1947), pp. 25, 39.

[3] Commission on Post-War Plans, Second Report of; *The Mathematics Teacher*, XXXVIII (May, 1945), 213.

"The crucial task of higher education today, therefore, is to provide a unified general education for American youth. Colleges must find the right relationship between specialized training on the one hand, aiming at a thousand different careers, and the transmission of a common cultural heritage toward a common citizenship on the other.

. . . . . .

"'General education' is the term that has come to be accepted for those phases of nonspecialized and nonvocational learning which should be the common experience of all educated men and women.

"General education should give to the student the values, attitudes, knowledge, and skills that will equip him to live rightly and well in a free society. It should enable him to identify, interpret, select, and build into his own life those components of his cultural heritage that contribute richly to understanding and appreciation of the world in which he lives. It should therefore embrace ethical values, scientific generalizations, and aesthetic conceptions, as well as an understanding of the purposes and character of the political, economic and social institutions that men have devised.

"But the knowledge and understanding which general education aims to secure, whether drawn from the past or from a living present, are not to be regarded as ends in themselves. They are means to a more abundant personal life and a stronger, freer social order."[4]

In implementing this program of general education the Commission states that:

"Numbers are . . . an important means of communication. We call mathematics into service in our daily lives much more frequently than is generally supposed. General education must provide a functional knowledge of the elements of mathematics that industrial society normally requires, and also the skill of quantitative thinking."[5]

Ore, after giving a somewhat equivalent grouping of junior college students, phrases his concept of the problem pertaining to mathematical instruction which emanates from this situation in these words: "On which principles should a single mathematics college course be organized so that it serves as well as possible the educational interests of those students for whom it will most likely represent the end of their mathematical studies?"[6] Such a concept of this rather critical educational problem is quite inadequate even when considered from the narrow perspective of the mathematics program alone. Newsom has called our attention to this inadequacy from one point of view when he has recognized that "a fundamental problem in the construction of a one-year course in general mathematics pertains to the fact that some students will become interested in the field of mathematics and will want to take advanced work in the subject."[7]

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[4] President's Commission on Higher Education, *op. cit.* p. 49.

[5] *Ibid.*, p. 53.

[6] Oystein Ore, "Mathematics for Students of the Humanities," *The American Mathematical Monthly*, 51 (October, 1944), 454–455.

[7] C. V. Newsom, "A Course in College Mathematics for a Program of General Education," *The Mathematics Teacher*, XLII (January, 1949), 22.

After a brief discussion of the difficulties and shortcomings of such a program he suggests that:

"The obvious solution to the difficulty . . . calls for a revision of the traditional curriculum in college mathematics so that the general course under consideration would merely become a first course for all students. Interestingly enough, much of the material covered in the better general courses is not duplicated anywhere in the traditional sequence so that *the student completing the general course will actually have a type of mathematical knowledge and an understanding of mathematical concepts that the typical major in the field does not possess.*"[8]

In his discussion of the "Chicago program of liberal education" Northrop has implied a still more fundamental criticism of the basic curriculum problem as phrased by Ore. After making the point that "in such a program there is no problem of designing and presenting several courses in mathematics at the first-year college level: one—presumably terminal—for students of the humanities, another for physical science majors, a third for engineering students, and so on," Northrop states his basic philosophy in these words: "A liberal education is presumably the kind of education everyone ought to have, regardless of the career he expects to enter. If this be true, then any mathematics course designed as an integral part of such an education should be one that every student ought to take, whether or not he plans to take further courses in mathematics."[9]

Mathematics constitutes an integral part of our cultural heritage. Many of its fundamental concepts, basic meanings, significant techniques, characteristic modes of perception and thinking, and aesthetic appreciations are essential "to a more abundant personal life and a stronger, freer social order." There is a body of mathematical content that is of significance to every individual capable of intelligent participation in the educational program, whether it be at the level of the elementary school, high school, or junior college.

The Content of a Freshman Mathematics Course

What should be the content of a course in mathematics so designed to present that material of greatest significance to the junior-college student irrespective of which of the four groups he is a member? This is a very difficult question to answer. Allendoerfer, thinking in terms of the terminal student, suggests a course, which he calls "Methods of Quantitative Thinking," which would "include an introduction to deductive logic, axioms, and abstract thinking; a thorough review of elementary algebra and arithmetic; a substantial treatment of probability and statistics; together with numerous practical applications to everyday quantitative problems"; also it should

[8] *Ibid.*, p. 23. Italics mine.

[9] E. P. Northrop, "The Mathematics Program in the College of the University of Chicago," *The American Mathematical Monthly*, 55 (January 1948), 2.

incorporate "material adequate to explain to the non-specialist the nature of mathematics and its contribution to our civilization."[10] Although one might wonder why the specialist should be deprived of the opportunity to learn something of "the nature of mathematics and its contribution to our civilization" and disagree with points in Allendoerfer's basic philosophy as well as some of the materials included in his suggested course, we would all agree with him when he says that: "We must be sure that the content of the course *is* mathematics and is not just *about* mathematics."

Ore suggests three basic principles which should serve as guides in the organization of such a course, namely: (1) It is desirable to give the course a larger measure of broadness with greater emphasis on first principles; (2) The attempt should be made to include some information on problems which students may encounter later in everyday life; and (3) The development of mathematics as an important branch in the history of thought should be presented.[11] Whether or not we agree with Ore's restricted concept of the function of the course under consideration, we are impressed with the broadness of these three basic principles.

Northrop thinks that the implications of the place of mathematics in a program of liberal education are that:

> ". . . the student should be taught to think deductively, to know what a deductive system is, to understand the relation between an abstract deductive system and its models, or concrete intrepretations, and to have some appreciation of what rigor is and how it may be achieved. Add to this the fact that he should learn, both for the skills themselves and for the part they will play in his later courses in science, how to understand and to deal with problems of quantity and space, and the content of a year course in mathematics appropriate to a program of liberal education becomes fairly clear: it should include at least the study of logic, algebra, and geometry."[12]

In the analysis of the implementation of this statement one cannot help but wonder if the course has been planned in the full spirit of the basic statement that it "should be one that every student ought to take, whether or not he plans to take further courses in mathematics." One gets a very definite impression that the selection of material is influenced more by a concern for those who are mathematically minded than by a concern for those who have no future interests in mathematics, or even by a desire to keep a wholesome balance between the interests of the two groups. Particularly is this true when one reads that the choice of those topics which constitute the course "is defended on the grounds that any student who has successfully

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[10] C. B. Allendoerfer, "Mathematics for Liberal Arts Students," *The American Mathematical Monthly*, 54 (December, 1947), 576–577.

[11] Ore, *op. cit.*, p. 455.

[12] Northrop, *op. cit.*, pp. 2–3.

fulfilled the course requirements will be able to pursue, independently and with understanding, any further topics in mathematics in which he may have a genuine but nonprofessional interest."[13]

Kidd found agreement among a group interested in the teaching of junior-college mathematics on the following objectives:

(1) The development of (a) habits of logical, accurate, and independent thinking, (b) habits of good workmanship, and (c) skill in analyzing problem situations, making generalizations from data, and in applying generalized statements to particular situations
(2) The development of an insight into elementary mathematics and an appreciation of its role in our advancing civilization with particular emphasis given to the function concept and an understanding of elementary statistics
(3) The ability to apply mathematical concepts and methods to the solution of practical problems.[14]

An unfinished study based on a careful analysis of critical incidents from business and industry seems to indicate that the mathematics program of the community college should be a broad general course with no formally stated prerequisites, designed to accommodate a wide range of interests and aptitudes, and giving principal emphasis to (1) basic understanding of the concept of number and skill in the fundamental operations including the use of elementary calculating machines; (2) ability to use formulas efficiently; (3) ability to identify the signficant facts in a problem situation and to arrive at a satisfactory solution; and (4) ability to make intelligent use of basic statistical measures.[15]

In our effort to construct that freshman course in mathematics that would interest the ambitious, challenge the studious, stimulate the industrious, and enlighten the curious, let us take counsel in the words uttered by A. N. Whitehead many years ago:

"The study of mathematics is apt to commence in disappointment. The important applications of the science, the theoretical interest of its ideas, and the logical rigour of its methods, all generate the expectation of a speedy introduction to processes of interest. We are told that by its aid the stars are weighed and the billions of molecules in a drop of water are counted. Yet, like the ghost of Hamlet's father, this great science eludes the efforts of our mental weapons to grasp it... ''Tis here,' 'tis there,' 'tis gone'... and what we do see does not suggest the same excuse for illusiveness as sufficed for the ghost, that it is too noble for our gross methods. 'A show of violence,' if ever excusable, may surely be 'offered' to the trivial results which occupy the pages of some elementary mathematical treatises.

"The reason for this failure of the science to live up to its reputation is that its fundamental ideas are not explained to the student disentangled from the technical procedure which has been invented to facilitate their exact presentation in particular instances. Accordingly, the unfortunate learner finds himself struggling to acquire a knowledge of a mass of details which are not illuminated by any general conception. Without a doubt, technical facility is a first requisite for

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[13] *Ibid.*, p. 5.

[14] Kenneth Paul Kidd, "Objectives of Mathematical Training in the Public Junior College," *Contribution to Education No. 394* (Nashville, Tenn.: George Peabody College for Teachers, 1948), pp. 130–133.

[15] Ralph P. Bentz, Unpublished manuscript.

valuable mental activity: we shall fail to appreciate the rhythm of Milton, or the passion of Shelley, so long as we find it necessary to spell the words and are not quite certain of the forms of the individual letters. In this sense there is no royal road to learning. But it is equally an error to confine attention to technical processes, excluding consideration of general ideas. Here lies the road to pedantry."[16]

Postulates Underlying a Freshman Mathematics Course

In this scientific age no professional divining rod nor educational radar is needed to discover the merits of mathematics as a functional part of the college freshman program. To determine the most significant content of such a mathematics course is a problem that will require a great deal of careful thought. This problem can be solved only through the careful deliberations of an interested group meeting around the conference table where the debating of issues will lead to the statement of principles which can be given the stamp of authoritative approval. It is possible, however, to glean from the literature and from individual thinking ideas which take the shape of basic principles which would seem to be postulates fundamental to the thinking of any such group. Not necessarily for your approval, but for your contemplation, may I suggest a partial list of basic principles which seem to me to be indispensable postulates for the thoughtful solution of the problem of determining the most significant content for a college freshman mathematics course.

1. The course should be one designed for all students capable of a junior-college education.
2. The course should be based on a minimum of formal mathematical prerequisites.
3. The content of the course may bear little resemblance to that of the traditional freshman course.
4. The content of the course must be *bona fide* mathematics and not mere descriptions and discussions of the nature of mathematics.
5. The course must be a broad course with a great deal of emphasis on fundamental concepts, basic meanings, significant techniques, characteristic modes of perception and thinking, and aesthetic appreciations; that is, a maximum of emphasis on first principles and a minimum of emphasis on mechanical details.
6. There must be a close relationship drawn between mathematical theory and everyday practice.
7. The intimate affinity between mathematical thought and cultural development must receive deliberate attention.
8. There must be a careful development of the nature of deductive thinking, and the student must be given opportunity to develop some appreciation of what rigor is and how it may be achieved.

[16] A. N. Whitehead, *An Introduction to Mathematics*, First American Edition (New York: Oxford University Press, 1948), pp. 1–2.

9. There must be careful emphasis on the techniques of problem solving and the principles underlying the procedures for making careful generalizations from organized data.

In closing I can think of no more sincere and apt way to try to convey to you the spirit and frame of mind out of which the thoughts of this talk have evolved than to use the words of St. Paul in his letter to the Phillippians: "Finally, brethren, whatsoever things are true, whatsoever things are honest, whatsoever things are just, whatsoever things are pure, whatsoever things are lovely, whatsoever things are of good report; if there be any virtue, and if there be any praise, think on these things."

OUR SCHOOLS

"More than 34½ million children and adults will be enrolled in the Nation's public and private schools and colleges during the 1952–53 academic year," said Oscar R. Ewing, Federal Security Administrator.

In releasing the annual enrollment estimates prepared by the Office of Education, Federal Security Agency, Mr. Ewing said, "Schools and colleges throughout the United States will record the highest total enrollment in history—34,693,000.

"This figure represents more than one fifth of our country's total population," said Mr. Ewing. It reveals the vastness of American education and the important role our schools and colleges play in helping meet the needs of our people and our Nation."

Reporting the 1952–53 enrollment estimates in detail and interpreting them, Earl James McGrath, U. S. Commissioner of Education said, "Public and private elementary schools this year will have approximately 1,600,000 more pupils enrolled than last year. The increase in number of secondary school pupils will be 95,000."

Commissioner McGrath said that the Nation would need 158,600 new teachers this fall to instruct additional numbers of pupils to be enrolled and to take care of normal turnover in teaching staff caused by teacher retirement, death, marriage, or change of position. Dr. McGrath added that the 158,600 new teacher estimate did not take into consideration new teachers needed to replace substandard and emergency teachers, to relieve overcrowded classes and double sessions, or to enrich the curriculum by the addition of new subject fields.

"We may expect to be about 52,600 short of the number of new teachers needed in September, 1952 to meet minimum demands," said Commissioner McGrath. "We just haven't been graduating enough teachers to fill the many thousands of positions which record elementary school enrollments are creating. And the problem of teacher supply will be with us for some time because we can expect another step up of 1,400,000 in elementary school enrollment in the fall of 1953, an increase of 1,200,000 in the fall of 1954, and another rise of 700,000 in 1955."

Commissioner McGrath continued, "These are startling statistics, but we must face reality. Our children are with us. Do we want to send them into overcrowded classrooms or into unsafe or insanitary schoolbuildings? Conditions are bad enough today but they may get worse. A national survey of school building needs being conducted by the U. S. Office of Education already reveals that we threaten the lives of thousands of our boys and girls daily by sending them into firetraps and unsafe structures. Sixty-one percent of the Nation's classrooms are overcrowded. One of every five pupils attends school in a building that does not meet minimum fire safety conditions. There has been an average of more than 2,100 school fires per year over a 15-year period."

STATIC CHARGES PRODUCED ON THE ENDS OF A CONDUCTOR MOVING ACROSS A MAGNETIC FIELD, WHEN ITS MOTION, LENGTH, AND FIELD ARE MUTUALLY AT RIGHT ANGLES TO EACH OTHER

S. R. WILLIAMS
Amherst, Massachusetts

No doubt many other teachers have picked up a meter stick from the lecture table, as I have done scores of times in 41 years of teaching, and said "If this meter stick were a conductor and moving with

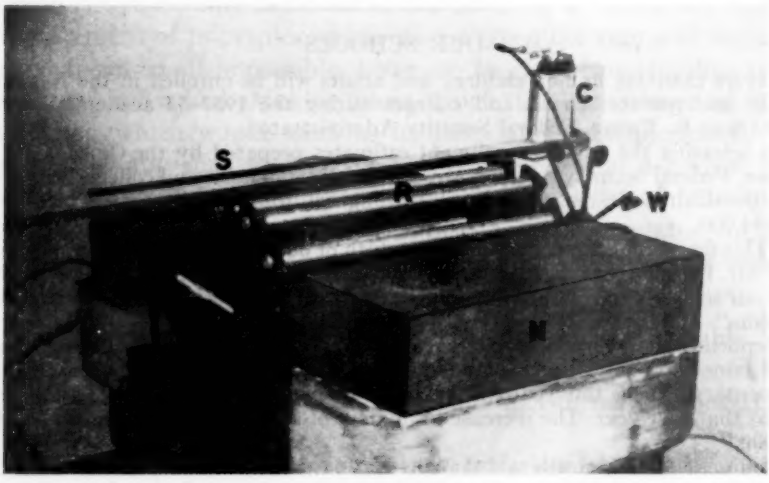

FIG. 1. A series of aluminum rods R move at right angles to the magnetic field between the poles N and S.

uniform velocity at right angles to the earth's magnetic field there would be developed on one end of the stick a negative static charge, and on the other a positive one."

Having now retired to think over the sins of omission and commission during these years of teaching physics, I have wondered how far the above statement penetrated without some sort of a demonstration. In spite of repeated attempts to make clear that electricity at rest or in motion is still the same thing, there lurks in the minds of our students an idea that there is something vastly different between these two agents. Of course, we recognize that electricity in motion produces a secondary effect we call magnetism, but over and above that the suspicion still lingers that static and current electricity are quite different entities. Surely the water in the mill-pond is no different from that which is rushing down the sluice to the water wheel.

Now that static machines such as the van de Graaff generator

have been built with currents which can be measured by ordinary ammeters, it has begun to percolate that from static charges one may actually go to current electricity, for

$$\text{Current} = \frac{\text{Charge}}{\text{Time}}$$

It seemed, therefore, not out of place to produce some sort of demonstration by which the mechanism usually employed in developing current electricity might be turned from that purpose over into a device for generating static charges. This would be the reverse process found in the van de Graaff generator.

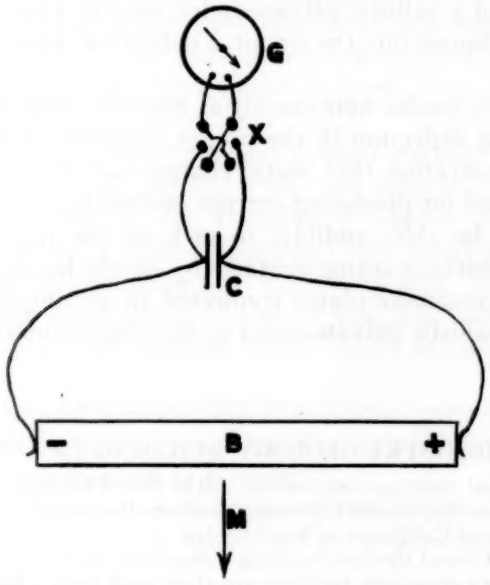

FIG. 2. The conducting rod B moves in the direction of M. A magnetic field is normal to both and into the page.

Accordingly, the following demonstration was devised in which a skeleton drum armature was used to carry 10 aluminum rods, 30 cm long, 1.25 cm in diameter, and 6.5 cm from the axis of rotation as shown in Fig. 1. It will be seen that each rod is being moved with uniform velocity, so that field, motion, and length of rod are all three mutually at right angles to each other,—as was the hypothetical meter stick mentioned above. Instead of these rods being cross-connected as they would be in a simple drum armature, they sweep down between two spring brushes, one at each end of the rod, as shown in Fig. 2. As the bars sweep through the magnetic field of the

pole pieces, N and S, there is developed a P.D. between the two ends given by the equation,—

$$\begin{aligned}\text{P.D.} &= HLv/10^8 \text{ volts} \\ &= 1000\times 30\times 1000/10^8 \text{ volts} \\ &= 1/3 \text{ volt approximately}\end{aligned}$$

In this equation H is the field strength in oersteds (somewhat over 1000), $L=30$ cm, the length of the rods, and $v=2\pi rn$, where $r=6.5$ cm and $n=30$ rps. The rotation was produced by a jet of air blown against a set of cup-like blades shown at W in Fig. 1. The brushes contacting the ends of the rod as they moved at right angles to the magnetic field were connected to the terminals of a 0.01 mf condenser, C. The terminals of this condenser were in turn connected to the binding posts of a ballistic galvanometer, so that when the reversing switch X was thrown into the circuit, a deflection of the galvanometer occurred.

Of course, the results were exactly as expected, and the galvanometer gave a big deflection in the proper direction. This experiment offers a demonstration that static charges can be built up by the means employed for producing current electricity.

One should be able, audibly, to pick up the presence of these static charges without spring contacts by simply having the rods run between two condenser plates connected to an amplifier and loud speaker. The ballistic galvanometer is the simplest method to understand.

$4,500,000 CHEMISTRY-GEOLOGY BUILDING IN LOS ANGELES

Planned for what many persons believe will be the "Chemical Age" of the next half century, a new $4,500,000 Chemistry-Geology Building has been completed at the University of California at Los Angeles.

It is considered one of the best teaching research plants of its kind in the West. The new building's chemistry facilities can train each term 1,500 freshmen, 375 students in quantitative analysis, 500 in organic chemistry, 90 in biochemistry and 150 in physical chemistry.

There is also laboratory capacity for 100 graduate students doing research and 13 post-doctoral research labs. In addition, there are 24 office-laboratory suites for the research work of staff members.

The geology wing contains modern classroom-laboratories, research laboratories, seminar rooms, a large geology library, a museum for displaying rocks, minerals and fossils and space for the Institute of Geophysics.

The five-story structure with 160,000 square feet of space is, in fact, six separate buildings. They are separated by about six inches and give the group unusual protection from earthquakes.

Sponge-rubber pad for hunters protects shoulders from painful gouges due to rifle recoil. Enclosed in a cloth pouch, the pad can be buttoned into a hunting coat or shirt, or fastened in with safety pins.

A SURVEY OF THE OPINIONS HELD BY ADMINISTRATORS OF RURAL CENTRAL SCHOOLS CONCERNING THE PREPARATION OF SECONDARY SCHOOL SCIENCE TEACHERS

ROGER W. MING
Cornell University, Ithaca, New York

The Department of Rural Education at Cornell University is interested in knowing how to better prepare secondary school science teachers. Since a large percentage of these teachers first secure positions in the rural central schools of New York State, it was thought desirable to obtain the opinions of rural central school administrators concerning the preparation they desired science teachers to have. During the Spring of 1951, the writer conducted a survey to procure this information for the Department of Rural Education at Cornell University.

The instrument of this study was a questionnaire. This questionnaire was addressed to the principals and superintendents of rural central schools listed in the *Directory of Central School Districts, 1950–51*, issued by the State Education Department at Albany, New York. The schools represented, therefore, were located in communities having populations of 4500 or less. The questionnaire was designed to obtain information which would answer the following questions:

1. What kind and what amount of academic preparation in science do administrators of rural central schools think it necessary for their science teachers to possess?
2. What types of science positions are available in the rural central schools of New York State, and to what extent is each type prevalent?
3. In what additional areas, other than the specific science courses implied in number 1 above, do administrators feel that science teachers should have experience and/or training?

The questionnaire was sent to 414 principals and 169 superin-

TABLE 1. TABULATION OF RETURNED QUESTIONNAIRES

	Principals	Superintendents	Combined
Possible number of returns	414	169	583
Actual number of returns	312	55	367
Percentage of possible number of returns represented by the actual number of returns	75%	33%	63%

tendents or to a total of 583 administrators. From Table 1 it may be seen that 75% of the principals and 33% of the superintendents responded by returning the questionnaires.

The writer feels that the percentage of response is sufficient to be a reliable representation of the administrators covered in the survey.

The questionnaire was organized in three parts. The information obtained from Part I of the questionnaire indicated the minimum number of college hours of training thought desirable in twelve specific areas of science. Inspection of Table 2 reveals the method employed to obtain this information.

TABLE 2. MINIMUM NUMBER OF COLLEGE HOURS OF TRAINING THOUGHT DESIRABLE

The Sciences Described in Part I of the Questionnaire	Combined Responses of Principals and Superintendents				
	Possible Number of Responses	Actual Number of Responses	Percentage of Response	Median College Hours	Mode College Hours
A. Physical Sciences					
1. Chemistry	367	352	96%	15	18
2. Physics	367	353	96%	15	18
3. Geology	367	274	75%	6	6
4. Astronomy	367	243	66%	3	3
5. Meteorology	367	226	62%	3	3
B. Biological Sciences					
1. Botany	367	320	87%	9	6
2. Bacteriology	367	277	75%	6	3
3. Zoology	367	307	84%	6	6
4. Entomology	367	217	59%	3	3
5. Ornithology	367	201	55%	3	3
6. Human Physiology	367	294	80%	6	6
7. Genetics	367	242	66%	6	3

For example, there was a total of 367 possible responses for each item in Part I of the questionnaire because a total of 367 questionnaires were returned. However, each item of each questionnaire was not completed. Table 2 indicates the percentage response for each item. The administrators were asked to indicate their choice of the number of college hours of training they thought desirable in each of the sciences listed in Part I of the questionnaire. The investigator, then, determined which number of college hours indicated, represented the statistical mode and which number of college hours indicated, represented the statistical median. The median and mode of the number of college hours indicated for each item were held to be significant.

It should be noted from Table 2 that, of all the sciences listed,

the administrators placed the most emphasis on training in chemistry and physics—a minimum of between 15 to 18 college hours of training in each one was recommended. Training in botany was ranked next in importance; the minimum amount of training recommended in this area was between 6 to 9 college hours. The training recommended in the rest of the sciences listed was between 3 to 6 college hours.

Part II of the questionnaire was designed to provide an answer to the question: What types of science positions are available in the rural central schools of New York State, and to what extent is each type prevalent? Since Part II of the questionnaire was quite objective, and since the responses of the superintendents would only be repetitious and not so complete as the responses of the principals, it was decided most feasible to base this part of the study solely on the reports given by the principals. Table 3 depicts the relative abundance of the positions described in Part II of the questionnaire.

Forty per cent of the available positions, indicated by the sample obtained in this study, are ones involving the teaching of both senior high science and general science; twenty-three per cent of the positions involve teaching junior high science only; while twenty-three per cent involve teaching senior high science only.

TABLE 3. RELATIVE ABUNDANCE OF EACH KIND OF TEACHING POSITION DESCRIBED IN PART II OF THE QUESTIONNAIRE

Description of the Position	No. Reported	Per cent
1. A single science course	29	6%
2. Senior high science only	96	23%
3. Junior high science only	99	23%
4. Combination of senior high science and general science	169	40%
5. Other combinations	33	8%
Total	426	100%

About six per cent of the teaching positions available in the rural central schools covered by this study are ones in which just a single science course is taught by the science teacher (for example, the teacher gives instruction in chemistry only, or in biology only, etc.). Finally, only eight per cent of the types of science positions reported fell into the category designated as "Other Combinations." Of the 33 principals who checked item 5 listed in Table 3, ten of them could have indicated the type of position by more properly checking one of the other four types of positions indicated in the same table. There were, therefore, only 23 types of combinations which could not be properly classified as one of the combinations other

than the one listed as No. 5 under Part II of the questionnaire. Of these 23, 14 or 61 per cent of them involved the teaching of science and mathematics in some manner.

Since some schools would have only one kind of science teaching position available and other schools would have more than one kind available, it was thought desirable to determine the number of schools having a particular type or types of science positions available. Table 4 summarizes this information.

Although it was noted that 40 per cent of the teaching positions

TABLE 4. SUMMARY OF THE NUMBER AND KINDS OF SCIENCE TEACHING POSITIONS AVAILABLE IN THE SAME SCHOOL

Number of Kind of Positions Available in the Same School	Number of Schools	Per cent
One Position: Combination of senior high science and general science	146	47%
One Position: Senior high science only	10	3%
One Position: Various Combinations (e.g., teaching science and mathematics or science and non-science courses)	22	7%
Two Positions: (1) Senior high science only (2) Junior high science only	74	24%
Two Positions: (1) A single science course (2) Junior high science only	10	3%
Two or More Positions: Miscellaneous combinations of positions not indicated in the above types	50	16%
Total	312	100%

reported are ones described in item 4 of Table 3, it is well to point out that Table 3 does not make a distinction between schools which have only that combination present and schools which have that combination present in addition to one or more other kinds of positions. In Table 4, however, that distinction is made. Thus, 146 out of 312, or forty-seven per cent of the schools reported by principals indicated that the only kind of teaching position available in their schools was a combination of teaching both senior high science and general science. Again, Table 3 reveals that twenty-three per cent of the teaching positions reported are ones which involve teaching senior high science only. Another twenty-three per cent of the teaching positions reported involve teaching junior high science only. Table 4, on the other hand, indicates that the two teaching positions just described are more often present in the same school than not. For, twenty-four per cent of the schools reporting indicated that there were two kinds of science teaching positions present: (1) the teaching of senior high science only and (2) the teaching of junior high science only. It should be evident, then, that the

only kind of science teaching position present in about 50 per cent of the rural central schools of New York State is one which involves the teaching of both senior high science and general science while in about 25 per cent of the schools the teaching of senior high science constitutes one teaching position and the teaching of junior high science constitutes the other.

Part III of the questionnaire was designed to obtain an answer to the question: In what additional areas, other than those specified in Part I of the questionnaire, do administrators feel that science teachers should have experience and/or training? Nine different areas were suggested in Part III, and in addition two blank spaces were provided for the administrators to make suggestions of their own. The administrators were asked to select at least three of the items from among those listed in Part III and rank them in order of decreasing importance (that is, 1, most important; 2, of lesser importance, and so forth). Part III of the questionnaire is reproduced in Table 5.

TABLE 5. REPRODUCTION OF PART III OF THE QUESTIONNAIRE

In what other areas do you think it desirable for *science* teachers to have had training or experience? Please select *at least* three which are, in your opinion, most important. Number your choices in order of decreasing importance (e.g.,1, most important; 2, of lesser importance; etc.).

1. Assisting with elementary science program	_____	6. Health	_____
2. Agriculture	_____	7. Mathematics	_____
3. Athletics	_____	8. Photography	_____
4. Conservation	_____	9. Social Sciences	_____
5. Guidance	_____	10. Other: viz. _____	_____
		11. Other: viz. _____	_____

From the total number of administrators who participated in this survey, the investigator determined which three of the items listed in Part III of the questionnaire received the highest number of responses as first choice, second choice and third choice. This information is summarized in Table 6.

Thus, from Table 6, it should be evident that 35 per cent of the administrators felt that *Assisting with elementary science program* was the most important item on Part III of the questionnaire; 33.5 per cent of the administrators felt that *Mathematics* was the most important and therefore ranked that item as their first choice; likewise, 17.0 per cent of the administrators ranked *Health* as their first choice. On the other hand, 20.0 per cent of the administrators felt that *Assisting with elementary science program* should be ranked as second choice; but 30.0 per cent of them felt that *Health* should be ranked as second choice; and only 14.0 per cent of them ranked *Mathematics* as second place. It should be noted also that 14.0 per

TABLE 6. SUMMARY OF THE THREE OR FOUR ITEMS OF PART III OF THE QUESTIONNAIRE RECEIVING THE HIGHEST NUMBER OF RESPONSES AS FIRST, SECOND AND THIRD CHOICES

Items (From Part II of the Questionnaire)	Choices					
	Frist		Second		Third	
	Number of Responses	Percentage Represented	Number of Responses	Percentage Represented	Number of Responses	Percentage Represented
1. Assisting with elementary science program	103	35.0%	54	20.0%	45	16.0%
4. Conservation			40	14.0%	44	15.0%
6. Health	50	17.0%	88	30.0%	65	23.0%
7. Mathematics	98	33.5%	42	14.0%		
All other items combined	42	14.5%	67	22.0%	131	46.0%
Total Number of Responses:	293	100.0%	291	100.0%	285	100.0%

cent of the administrators ranked *Conservation* as their second choice. For third choice, 16.0 per cent of the administrators indicated *Assisting with elementary science program;* while 15.0 per cent indicated *Conservation;* and 23.0 per cent indicated *Health.* The data, thus far presented, would suggest that most administrators in the group contacted through this study consider that *Assisting with elementary science program, Health* and *Mathematics* are highly desirable areas of knowledge in which the rural central school science teachers should have training and/or experience. These administrators likewise consider the area of *Conservation* to be of next importance.

SUMMARY

What kind and what amount of academic preparation in science do administrators of rural central schools think necessary for their science teachers to possess? The findings of this survey indicate that administrators feel that science teachers should have a relatively thorough training in chemistry and physics—a *minimum* of between 15 to 18 college hours of training in each subject. Furthermore, the administrators feel that science teachers should have taken at least an introductory course in a variety of the other physical sciences such as geology, astronomy, and meteorology. These administrators also feel that science teachers should have between six to nine college hours of training in botany and that they should have taken at least introductory courses in a wide variety of the other biological sciences such as bacteriology, zoology, entomology, ornithology, physiology and genetics. Summarizing in one statement, then, secondary school science teachers should have an *extensive training in the whole field of science rather than an intensive training in any particular branch of science.*

What types of science positions are available in the rural central schools of New York State and to what extent is each type prevalent? Analysis of the data obtained in the survey indicates that the science teaching position in rural central schools which is most prevalent is one which involves teaching both senior high science and general science. 47 per cent of the schools returning the questionnaire reported this type of science teaching position as the only one extent at that time. The science teaching positions involving the teaching of senior high science only and of junior high science only are equally prevalent and moreover the two positions just mentioned are usually associated together in the same school—in fact, 24 per cent of the principals reporting indicated that these two kinds of science teaching positions were coexistent in their schools.

In what additional areas, other than the specific science courses mentioned in the first paragraph of this summary, do administrators feel that science teachers should have training and/or experience? It may be concluded from the opinions expressed by the administrators that *assisting with the elementary science program, health,* and *mathematics* are important additional areas of knowledge in which training and/or experience is desirable. Of lesser, yet significant importance, according to these administrators, is training and/or experience in the field of *conservation*.

SPRAYING FROM HELICOPTER FIGHTS FOREST INSECTS

New spray equipment is putting the helicopter in the front line of our agricultural defense just as this type of aircraft has become an essential in Korea.

The new hovering sprayer can do jobs that no other aerial or ground spray machinery can accomplish, the U. S. Department of Agriculture and the Connecticut Agricultural Experiment Station have determined.

Helicopters can hover over normally inaccessible forest areas, covering them with insecticides to reach for insects that hides in bark crevices. They can fight mosquitoes, pests in cranberry bogs, place hormone sprays on orchards and weed-killers on fields with accuracy impossible with even slow airplanes.

The two 25-gallon tanks of spray carried are centrifugally pumped and atomized by both the air from the helicopter's engine fans and the engine exhausts. The revolving blades of the helicopter rotor waft the spray downward toward the ground.

2-MILE UNDERSEA PEAK DISCOVERED IN PACIFIC

An underwater mountain peak rising more than two miles (12,192 feet) from the ocean floor was discovered during the 14,580-mile Pacific cruise of the research vessel Horizon just returned here. The new seamount is 1200 miles west of Acapulco, Mexico.

Fishes that live a quarter mile deep below the sea's surface, below where sunlight reaches, were dredged up. These included extraordinary numbers of young lantern fish. Another discovery was pieces of pebble-sized volcanic pumice, floating in the sea, inhabited by minute marine creatures.

SIMPLE APPARATUS FOR DEMONSTRATING THE GAS LAWS

MENNOW M. GUNKLE
Thornton Township High School and Junior College, Harvey, Illinois

Boyle's Law. In the High School chemistry course when beginning the study of the gas laws the instructor may be at a loss for demonstrative equipment other than the usual gas law apparatus.

When students meet a gas law apparatus, one kind or another, they are confronted with many conditions at once. If this could be approached from a viewpoint of the layman there might be an easier time with the gas laws as a unit.

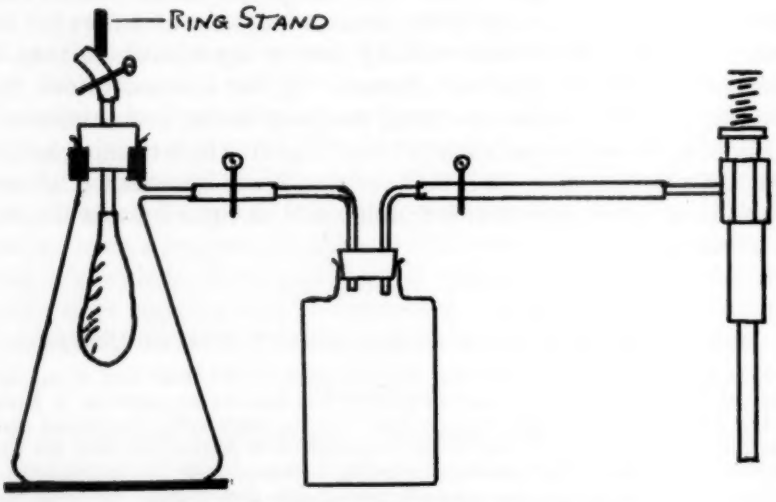

FIG. 1. Diagram of Boyle's Law apparatus.

Generally, students know the gas laws in a simple way before coming to a physics or chemistry class. They may not know their application but most could state that "when a gas is heated it expands; when a gas is cooled it contracts," and that, "a lot of gas can be put into a small container." However, applying given values for a changing condition is another problem. This problem need not involve all the changing conditions at one time. Observing what happens when pressure is reduced, or increased, may be a start in clearing up a vague situation. An apparatus for this observation need not be equipped to measure the changing conditions.

The apparatus and its construction. When a vacuum pump is not accessible a demonstrative apparatus for showing what happens to volume, when pressure changes occur may be done with a suction

flask, a rubber stopper, some glass tubing and rubber tubing.

A suction flask is fitted with a one-hole rubber stopper through which a piece of glass tubing extends about two inches on either side. To the end of the glass tubing on the inside of the flask attach a toy balloon with a rubber band. Place a short piece of rubber tubing (1–2 inches) on the upper end of the glass tubing and clamp with a pinch clamp. Attach one end of a piece of rubber tubing to the side arm of a suction flask and the other to an aspirator. It is good to

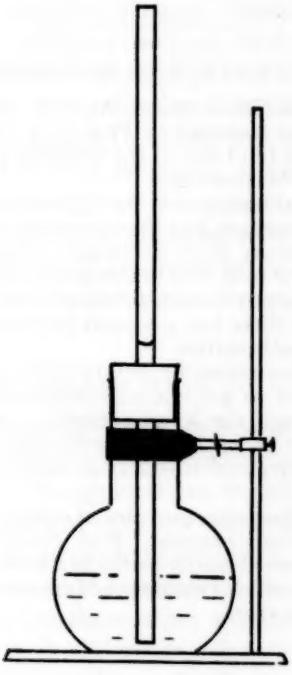

FIG. 2. Diagram of Charles' Law apparatus.

have a pinch clamp or glass-cock between flask and aspirator. The apparatus is easily put into operation. Below is a diagram of the device with a water trap between the flask and aspirator.

This apparatus is not a scientific measuring device but it will illustrate decrease and increase in pressure—Boyle's Law.

When students can see inverse proportion demonstrated problem solving logically becomes easier.

Charles' Law. Charles' law may be demonstrated by another simple apparatus. "Heating a gas causes it to expand; cooling a gas causes it to contract," is the observation made with this instrument. This again, is not a scientific measuring device.

The apparatus and its construction. Construction of the instrument involves assembling a Florence flask, a one-hole rubber stopper, and a piece of glass tubing about two feet long. The glass tubing should extend into the flask so that the end is close to the bottom. A colored solution may be used and should be sucked up into the tubing so that when assembled the level of the liquid rests high in the tubing.

When cold water is run over the flask the level of the column of solution is lowered; hot water run over the flask raises the level of the solution, demonstrating Charles' Law.

ARTICULATION IN MATHEMATICS

The problem of articulation between the high school and college level of mathematics teaching, was discussed by Prof. C. V. Newsom, University of the State of New York, at the third day of the University of Wisconsin Symposium on Teacher Education in Mathematics.

"This matter of articulation between the high school and the college concerns not only the training of teachers, but the curriculum itself," Prof. Newsom told participants of the symposium. High school and college people will have to work together so that the work of both may be integrated, he explained.

Pointing to the "tremendous dissatisfaction with the high school preparation," Prof. Newsom noted that there was a general feeling that the high schools were not doing "the job" in mathematics.

"Our high school teachers must be well-rounded individuals," he said. It is important for the student to get not only mathematics but related matters. High school teachers should also know something about children and how to keep their respect. A good background in the concepts of physical science and in the development of our civilization is also an important factor, Prof. Newsom added.

The philosophy of mathematics provides us with a pattern of thought, "and helps man understand his environment," Prof. Newsom stated.

The symposium is sponsored jointly by the Mathematical Association of America and the National Council of Teachers of Mathematics, with the co-operation of the UW School of Education.

NEW FILMS

A new British Information Service release, "Caribbean," is being distributed by Instructional Films for use in social studies, geography and economics classes, along with a beautiful color film "Mount Ranier."

The film, two reels in length, is 16 mm black and white, and is listed at $85 per print. It is available through all Instructional Films dealers, or through the home office at 1150 Wilmette Avenue, Wilmette, Illinois.

"Caribbean" takes a quick tour about the British Caribbean island possessions. Calypso music, native dances, and the life of the people is shown in a context of the economic problems of agriculture and industry.

The efforts of the islanders to lift themselves to a higher plane of living through education is shown graphically through some remarkable photography.

Instructional is also distributing another graphic new release, "Mount Ranier," in color. The film is the ecology story of this famous northwest mountain, from the land of eternal snows to its sloping footlands.

It will be a valuable addition to geography and science classes. Running time is 11 minutes.

EDUCATING POTENTIAL TEACHERS OF SOILS

WM. A. ALBRECHT
University of Missouri, Columbia, Missouri

If the knowledge about soils has grown to where it is now organized into a science, as we grant, then the learning of this science becomes another one of the disciplines of getting an education. The teaching of the subject of soils then, may well be put into the same category with the teaching of physics, botany, chemistry, zoology and the other sciences. The knowledge of soil can then be put along with that of these other sciences as an integral part of a *higher* education.

The subject of soils, as a science, calls for a knowledge of the facts. It calls for the capacity to reason logically by means of them under various situations. If it were only a matter of collected practices, then it would call merely for the capacity to use or to apply certain practices and skills centering about soil management. Teachers of soils must, then, first and foremost be *educated in the science* of soils just as they must be in any other science, and not just *skilled in a collection of practices.*

BOTH MATERIALS AND METHODS ARE REQUIRED

The problem of educating future teachers of soils is then, first, one of helping them acquire fundamental knowledge, and second, one of helping them see its applications in the soil as a natural body under judicious management of it for the production of crops. Since soil science consists of properly integrated parts of many other sciences, it is helpful to see the science of the soil through the same principles by which we see these other sciences. For this view of soil science, a familiarity with the other sciences is a requisite. Just as any other science makes system and order out of seemingly chaotic collections of facts by relating and integrating them into principles, so soil science must be well integrated in the mind of one who would teach it. The teacher of soils must first know the sciences and all else that constitutes the soil science.

When once the teacher has organized considerable knowledge of soils, it is well that he give some attention to methods of presenting his knowledge in such a manner that it may be a stimulation for students to gather similar knowledge in this subject. The problem in education of teachers of soil is first of all one of having fundamental knowledge organized into principles. In the second place it is one of knowing psychological skills, or tricks, by which some major equivalent of that knowledge can be aroused in the minds of those being taught.

Teaching of most any subject is more a problem of having something to deliver than of having only the means of transporting or delivering it. It is a problem of filling the teacher with subject matter, with its significance, and with an enthusiasm in its application so fully that their overflow from him can not be prohibited. One can not teach a system of how to teach soils and then expect the embryo teacher to acquire later the subject matter necessary for success in teaching it. Quite the opposite, if we can fill the future teacher to overflowing with the fundamentals of soils, he may find for himself the better methods of passing them to others.

A Growing Science Demands a Growing Teacher

If we are to help the potential become the actual teacher of soils there are some aspects of the subject matter, some characteristics of the teacher, and some problems in teaching, in general, that deserve special mention. In connection with the subject matter of soils, the future teacher of it dare not merely mimic the subject matter presented by the teachers of the past. The knowledge of soils is increasing tremendously. Soil science is a growing science of such wide implications that subject matter arrangement of soils today dare scarcely serve as the teaching pattern for a very long time in the future. One needs only go over his past experiences under teachers of himself or his own past service as a teacher to recognize the past excessive fragmentation of this subject and the changes coming constantly. We learned once that soil texture was a physical property. It helped to classify soils. Nitrogen content was a chemical property. Soil classification was a test of memorizing a vast collection of seemingly meaningless names. All these were tests of memory for a chaotic collection of facts. Today those fragments have all been integrated into the great story of how rocks disintegrate and decompose under climatic forces in the course of soil development for either the construction or the destruction of the soil and its fertility combinations to nourish plants and higher life dependent on them. Reproducing the fragmentation of the past as a conglomeration of scattered facts and providing a handbook of the recommended practices in soil management can not be effective teaching of soils in the future. Teachers of soils must be soil scientists with a capacity to tell the story of soils as the foundation of agriculture and all dependent on it.

Capacity to Reason Rather Than to Memorize Facts Is Required

The delivery of merely a collection of isolated facts centered about the subject of soils is not successful teaching of it. Good teaching

demands the inter-relation of facts, the connection between those that are causes and those that are effects, and the orders or successions of the particular facts by means of which they become the principles that underlie the practices of sound soil management. It is the reasoning by means of the facts and not only the recognition of them that must be demonstrated by the teacher and be followed by the students. The future teacher of soils may well remember that the subject matter of soils, especially as recorded in many older texts, is still too near the day when it was only a collection of fragments instead of the higher science calling for most able teaching talent and demanding the more intense interest of the good student.

Interest in the Subject Is Not Self-generative

Unfortunately, the subject matter of soils must be taught to the students who have had little or no previous interest aroused in it. Unlike other sciences, the soil has awakened no youthful or childish interest as do animals, plants, rocks, etc. Soil has not become the object of the collecting instinct early in life. In fact, soil has not only had little interest, but has had rather a negative interest. In the pre-college life it was only "dirt." The soil has always put a stigma on any one who collects significant amounts of it. No State Fairs ever exhibit soils, and no one would be thrilled by a passing parade of them. They can't be led into the show ring and draw public applause even if they might warrant the prize ribbons. The sight of a soil exhibit doesn't arouse one's appetite. The subject of soils calls for an appreciation of the cold facts well organized as a result of much diligent study, and, unfortunately, therefore the subject of soils has no appeal either ancient or more modern.

As a consequence, the teacher of soils must recognize the hindrance to good teaching in the simple fact that students come with little or no concern about soils per se. Rather theirs is a pseudo-interest propped up by the desire for a college degree in agriculture for which credit in soils is required on the books of the registrar. Perhaps there is no greater problem in teaching soils than in making the subject dynamic enough to arouse human interest in it to the point of provoking the student's real study of it. Unfortunately, for most students in soils, they find themselves experiencing the beginning of a distinct interest just about the time the course draws to a close.

Soils, a Science in a Professional School

The characteristics of the good teacher in soils are numerous and might be tabulated in many details. But it is sufficient to point out that the teacher of soils recognizes the difficulty of teaching a science in a distinctly scientific manner within a distinctly professional

school. When the general teaching attitude in professional schools is apt to be one of using handbooks, instructing in practices, adhering to traditions, measuring results in terms of dollars and cents, making the best of estimates and then using factors of safety as large as one hundred percent, it is difficult to lead the minds of students to go from causes to effects, to arrange facts in proper order for establishing principles, and to lead them to observe, to diagnose and to prescribe rather than to mimic the practice of some predecessor. The teacher of soils must recognize the need to teach the science of soil in its specificity and not only the practices of soil in their generalities.

Then, too, in soils as in teaching any subject, a teacher must shift himself early from being in the subject of soils because it represents a job as contrasted to his teaching this science because he is qualified for, and intersted in, it more than in anything else. The teacher who is not full of, and is not interested in, his subject certainly can not create much interest on the part of the students under him. Federal pay possibilities in soils surely can not be proper encouragement for one to try being a temporary teacher in soils.

Guided Teaching Experience Is Needed

Potential teachers in soils, like all teachers, must have opportunity to gain supervised teaching experience. To get experience they go forth too often with no instruction in pedagogy and no help in their first teaching venture. Outside of vocational agriculture, graduation from a College of Agriculture calls for no courses in education. Degrees in agriculture do not demand a course in psychology. They demand none in logic, and none in classification experience as is common in taxonomy of plants or in qualitative chemistry. Courses in agriculture are mainly training in agricultural practices, too often with sciences as a hindrance rather than as a help. This attitude toward sciences has encouraged a kind of inbreeding in our agricultural faculties to emphasize the practices and politics of agriculture to the point of making them the dominant character in the graduates while the sciences have become a recessive one or have almost been bred out. Too little study challenges the student's capacity to solve a new situation in light of accumulated past knowledge. With such training and with insufficient education in fundamentals, the potential teacher of soils ventures forth more because he has a degree than because he is innately, or by education and training, a capable teacher. As a consequence, he buys his apprenticeship in teaching at the expense of the poorly taught students under him during his preliminary experience of making a teacher of himself.

As a remedy for this situation, a teacher of soils may well be first, a capable student in the sciences in general with a major interest in

soils; second, a student assistant in some courses in soils; and third, a graduate student with research experience in this his chosen field of future work. If to this order of his training and educational experience there can be added considerable travel experience and a deep interest in geography, then a good teacher of soils is in prospect.

A good teacher is not one who submits himself as a student to be made into such. Rather he is that person who diligently struggles to make a teacher of himself. This is the basic tenet in becoming a teacher of soils as it is in becoming a teacher of any other subject. The education of potential teachers in soils then calls not so much for us to make teachers of them, but rather to provide the maximum of opportunity for students to make teachers of themselves while still in their educational program and before they take a position in the teaching profession with the science of soils as their choice.

A VIEW OF THE EARTH FROM 70 MILES UP

A striking new Encyclopaedia Britannica Films, Inc. release, which utilizes a view of the earth from 70 miles up plus experimental footage of rockets and jets, has been released for use in physics and science classes.

Walter Colmes, EBF president, described the film, "Laws of Motion," as a "striking addition to the new EBF science films. It was photographed in color because we felt this was a place where color would enhance the film."

"Laws of Motion," produced by Dr. Milan Herzog, EBF associate producer, takes each of Newton's three laws of motion and explains the theory behind each. Then, by carefully-chosen applications, utilization of each law is made explicit.

Moving billiard balls demonstrate the law of inertia. Through stop-motion photography, the application of this law in automobiles, a flying baseball, and a starting locomotive is made graphic.

On the second law, the concept of acceleration is first applied to common scenes, such as diesel trains, and then is developed into its other phenomena, such as centrifugal force.

Development of the third law of motion follows naturally out of this second discussion, and is where the rockets and jets enter in really spectacular applications. Special laboratory equipment, supplied by Central Scientific Equipment Company and by Weber & Costello was used to illustrate the principles of action and reaction.

Collaborator for the film was Dr. O. W. Eshbach, dean of Northwestern University Technological Institute, and the author of many scientific texts. A winner of the Octave Chanute medal, he is a member of many outstanding scientific groups.

"Laws of Motion" will be followed by a second film in the same field, "Jet Propulsion." This specifically illustrates Newton's third law as applied to the jet propulsion of aircraft. Collaborator on this film was Dr. John Rettaliata, new president of Illinois Institute of Technology.

Pre-fabricated knotty-pine room interiors are made to order from plans supplied by architects or homeowners. The interiors come complete with facing for doors, windows, closets and decorative trim necessary "to do the job." Numbered pieces help the buyer to install the interior himself.

VITALIZING THE CLASSROOM—FIELD TRIPS AND EXCURSIONS

SAM S. BLANC
East High School, Denver, Colorado

Field trips and excursions, as techniques for vitalizing the classroom, are among the oldest methods known. As concrete learning experiences, these procedures have many educational values. This type of activity is dictated by the best thinking in educational psychology and philosophy. It is a profitable technique capable of changing the rhythm of day to day instruction. And it is within the means of every teacher, since the materials for instruction are at hand on every side in and around the school. A field trip or an excursion may be defined as a planned visit to any point outside the regular classroom. It may be an excursion to some part of the school itself, to the grounds adjacent to the building, or to some area in the surrounding community. Whether taking half an hour or a whole day, the field trip has certain values and certain techniques which the teacher should know.

To a large degree the world of the pupil encompasses his home and his community. That is where he has many experiences which contribute to his education. There are formulated the many questions which enter his mind. And the answers can not always be presented in the classroom. To meet this need, it would seem logical that the pupils should be able to learn, under the direction of the teacher, outside of the classroom. More than any other types of instructional activity, the field trip must be planned with care. Too often pupils regard any activity outside the confines of the school building as a "lark." Pupils must be taught to regard an excursion as an educational experience. Planning a successful field trip is work, but the values derived should compensate the teacher for the extra effort involved.

Field trips can prove to be a most interesting and instructive method of education, and can become a means of leading pupils to make actual applications of their classroom learning. This activity offers respite from straight textbook study, and yet there are few procedures which will be as adequate in instilling a desire for more textbook usage and a more concentrated study in some areas of learning. An excursion is one of the best means of integrating various school subjects. It is also useful for introducing a unit of work, teaching a group of concepts, or summarizing the area covered in the classroom.

If a field trip is to be really successful, it must be carefully planned and executed. The class should be prepared for the trip, and the

activity should grow out of the pupils' interests so that they will be ready and anxious to take part. The proposed excursion should develop out of the work in some area which the class is studying, and it should serve to answer questions which the pupils have presented. Before any field trip is taken, the teacher should consider all possible places available, and decide on which is best from the standpoint of accessibility, and from the standpoint of how explicitly the excursion demonstrates the principles and concepts to be taught. The only way to actually determine these two points is for the teacher to take a preview trip to study the area.

If the pupils want to take the field trip, they will want to participate in the planning for the activity. With proper guidance they should be able to plan for the safety factors on the trip, and how to conduct themselves en route to and from the destination and at the place of the excursion. The pupils should be led to make plans for the necessary types of clothing, the equipment to be taken along, lunch, if necessary, and rest stops. The things to look for, the specimens to collect, and the notes to make during the trip should be worked out in detail during this planning period.

Once on location, active instruction should begin. One of the best procedures is to give the pupils a few minutes to look around and to discover and collect the items they had decided on bringing back to the classroom. The group must be under control at all times, and at a given signal, the class should assemble around the teacher. As the trip progresses, the teacher will assemble the pupils at each predetermined point of interest for observation and discussion. At each of these stations the pupils should be in a compact group facing the teacher. Pupils should not be allowed to gather behind the teacher at these observation points. The teacher should carefully consider the position of the group in relation to the object under consideration. The pupils should not have the sun in their eyes, and the teacher should not have to talk against the wind. The whole class must be in a position to see and hear if the discussions during the excursion are to have a maximum value. A few carefully planned questions will stimulate pupil participation in recognizing and discussing problems. With a little guidance, pupils will answer each other's questions, interpret the observations, and relate them to important principles and connected concepts.

On the return to the classroom, discussion of the field trip should be continued. Describing the objects and processes observed should lead to generalizations of the important concepts gained in the activity. An opportunity to express through art and music some of the things which the pupils have observed should be encouraged. Certainly, more reading in the area covered by the trip should be a

normal outcome. Written reports on various aspects of the excursion, with oral presentation to the class, make a worthwhile method of summarizing many of the understandings developed during the activity. Of course, other instructional materials should be brought into the classroom to help clarify and crystallize the concepts and ideas gained in the primary experience.

However, class work and interpretation of natural phenomena should not be the only outcomes of a good field trip or excursion. During the follow-up activities, the pupils should be led to probe the existing knowledge of the class in the particular area in order to gain new insights. Thus, the field trip may summarize old concepts, and by their use in actual situations, teach new concepts. Through actual learning experience, the pupils should be able to develop the power of observation and thinking in new areas of activity and interest, thus making their school life real, vital, and, above all, interesting and concrete.

A SHUTTER TIMER EMPLOYING THE STROBOSCOPE

G. E. BRADLEY
Western Michigan College of Education, Kalamazoo, Michigan

It is sometimes necessary to calibrate the shutter speed of a camera in the laboratory. If one is fortunate enough to possess a stroboscope[1] or its equivalent, this may be carried out quite simply. If an electronic scaling circuit as used with Geiger Counters is available, some convenience is added.

The light from the strobotron is focused thru the shutter onto a phototube (929 is suitable). The output of the phototube is delivered across a one meg-ohm resistor to the vertical deflection amplifier of an oscilloscope which is running with a slow recurrent sweep. The number of pulses seen on the scope as the shutter is opened and closed is a measure of the shutter speed. It may also be observed if the shutter is fully open for the interval by noting the equality of heights of the pulses. Counting of the pulses may be done electronically by connecting the phototube output to an electronic scaler. The pulse from phototube is quite large enough to acuate the conventional scaling circuit.

This method has the advantage over the photographic techniques in that no delay is introduced by the development of the film so adjustments may be made immediately. Furthermore, by means of viewing the pulses on the oscilloscope it is possible to determine if

[1] Strobotac (manufactured by General Radio, Incorporated) was used in this experiment.

the shutter is "wide open" during the whole exposure time.

Figure I shows the schematic diagram of the apparatus. Figure 2 is a photograph of one trace of the oscilloscope sweep indicating that eighteen light pulses from the strobotac negotiated the shutter

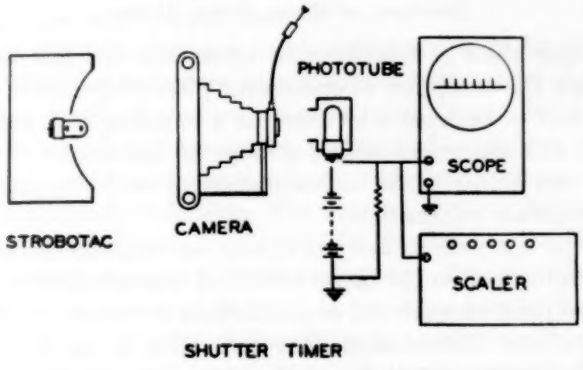

FIG. 1

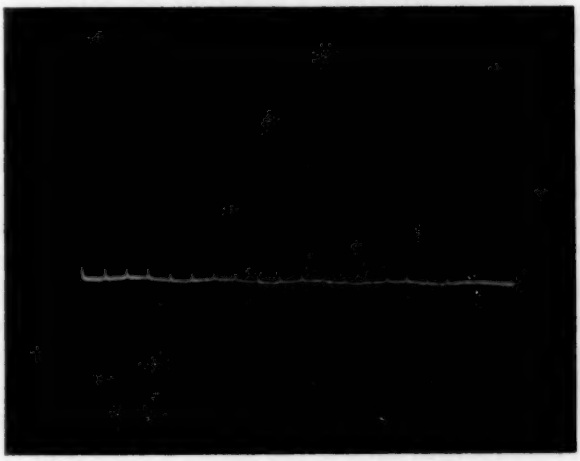

FIG. 2

while it was open. Since the strobotac was running at twice the power line frequency the time interval between pulses is 1/120 sec. Therefore, we conclude the shutter speed is 18/120 or 0.15 sec.

Dr. Roy K. Marshall, noted Educational Director of Science WFIL-TV "The Nature of Things," will address the New Jersey Science Teachers' Association November 7 at a luncheon in Haddon Hall, Atlantic City. At that time President Mary Lutz will present an award to an outstanding science educator and a long time friend of the NJSTA. This award goes to Dr. Rufus D. Reed, Head of the Science Department, State Teachers' College, Upper Montclair, New Jersey.

THE UNIQUE PLACE OF TELEVISION IN EDUCATION

ROBERT E. SCHREIBER
University of Maine, Orono, Maine

The unique place of television in education has not been determined. With the exception of one recent piece of research, it has not been determined because television, as a teaching aid, has not been studied. If this statement seems strange to the reader, it is just as strange to the writer—that such a statement could be made without fear of immediate contradiction.

During the last year or more the press has kept the profession and the public informed on the latest efforts of representatives of a number of prominent educational organizations to convince the Federal Communications Commission that television is an important instructional aid. This group has insisted, to the F.C.C., that a large number of telecasting frequencies should be set aside for exclusively educational, non-commercial use. Colleges and universities and school systems have been bombarded with instructions as to how they might assist in bringing to bear additional pressure on the F.C.C. Lengthy testimonials by prominent people on the alleged virtues of television as a teaching aid have been sent out; some at government expense.

The initial phases of the campaign have been successful: a large number of telecasting frequencies have been set aside, tentatively, for educational use. The current effort is to get educational groups to apply for licenses and begin building stations before the frequencies revert to the commercial telecasters by default. The fact that these stations are costing thousands of dollars to build and still further thousands to maintain—not including the high costs of securing enough television sets in each of the nation's schools to use the programs to be broadcast—raises the question—"What is the unique place of television in education?"—out of the realm of the academic and into the sweat and tears of everyday economics.

In its impact on the senses of sight and hearing, what is the television program most nearly like? The answer is, rather obviously, the motion picture. The fact that much of what is seen on commercial TV is already on film might seem to clinch the similarities. There are considerable differences between the TV picture and the motion picture, electronically. The differences between the two, educationally, seem to boil down to these two:

1. The live (non-film) television program is an instantaneous reproduction of some, perhaps distant, event; whereas the motion

picture may be a reproduction of the same event that is then projected for study at some later time. Out of this difference in timing arises the question: "Do students learn more when they know that what they see is happening somewhere at the exact instant of their looking, instead of being a record of an event occurring several weeks, months, or years previously?"

2. The second difference, educationally, is one of flexibility in use. The live television program comes on only once and must be used then or not at all. It cannot be previewed, it cannot thus be adequately prepared for, it cannot be interrupted for questions, it cannot be repeated, and it may come on at a completely inopportune time. It is, in a nutshell, inflexible. The motion picture, in contrast, has none of these disadvantages; is QUITE flexible.

Due to the electronic differences between the television program and the projected motion picture, there is no way to have the two aids trade places in terms of flexibility. It is only possible to telecast the motion picture, as is frequently done at present, and thus convert it to the same rigidity as the live television program. This means that, in order to use television to any appreciable extent in the classroom, the telecasting schedule must be suited to the individual teacher's instructional needs and schedule. Obviously, the resources of a $100,000 station cannot be so diverted. Thus, the teacher must suit his teaching schedule to the telecasting schedule. Teachers found that this did not work out well with educational radio. It is questionable whether they will welcome a repeat of the same problems with television. Should the tail wag the dog? Should the mass approach replace individual instruction? In the past the answers to such questions have usually been "no." There *is* one condition under which educators would do well to reexamine their traditional approach to such questions.

If it can be proved that the television program is an outstandingly better teaching aid for most subjects in the curriculum than the motion picture and other materials already available, the profession would then be faced with the difficult decision as to whether, in view of the greater effectiveness television might have, it would be better, for the children, to turn over the planning of the school program to the personnel of the educational television stations. However, the available evidence does not warrant any such soul-searching at this time.

There has been only one study completed to date that in any way bears on the question: "Is a television program a better teaching aid than an identical motion picture?" In this study, which was aimed primarily at determining whether groups of young adults could be effectively taught by means of a televised instructor or a motion

picture of the resulting telecast, instead of by a group of individual instructors, one of the findings was that 16% of the students learned more from a television program than from viewing an identical motion picture of the television program at a later time.

This one study is the only evidence available at present comparing the effectiveness, educationally, of a telecast with an identical motion picture. It is, then, the only pertinent evidence bearing on the "immediacy" (instantaneous transmission) of the television program insofar as this immediacy affects increased learning. More comparative studies with children of different ages and of presentations in various subject matter areas need to be arranged to fully clarify the differences between the motion picture and the telecast. Comparisons of television programs, as teaching aids, with other materials should also be made.

What is the unique place of television in education? Powerful groups, without pertinent documentation, maintain that it *is* unique —insist that teachers, parents, and other taxpayers must believe that it is and act accordingly. This is neither the way of science or of common sense. When television, as a teaching aid, can be honestly defended, it will be time *then* to *act*.

SEPTEMBER OF 1752 HAD ONLY 19 DAYS

Thursday, Sept. 14, followed immediately after Wednesday, Sept. 2, in the year 1752. Many people felt they had been robbed of 11 days, and riots resulted. "Give us back our fortnight!" was a familiar cry.

The cause of this peculiar short month was the introduction of the Gregorian calendar, adopted two centuries previously in many Catholic countries, into England and the American colonies.

The Julian calendar, used by many countries at the time, was not based upon an exact enough estimate of the length of the tropical year. As a result the vernal equinox, which occurred on March 21 at the time of the Council of Nicaea in 325 A.D., began arriving earlier and earlier. By 1582 it fell on March 11.

The sun is responsible for all the trouble man has experienced throughout the ages in trying to develop a reliable calendar. Instead of completing its apparent trip among the stars in an even number of days or hours, the sun takes 365 days, five hours, 48 minutes and 46 seconds to return to an equinox.

To make a more exact calendar, Pope Gregory XIII, upon the advice of the astronomer Clavius, in 1582 ordered the calendar corrected by dropping ten days. In France, Spain and other Catholic countries, the day following Oct. 4, 1582, was called the 15th instead of the fifth.

To avoid further displacement of the beginning of spring, Gregory decreed that the rule of adding an extra day every fourth year should be followed except in the case of those century years whose number is not divisible by 400. Thus 2000 A.D. will be a leap year, but 2100 will not, nor was 1900.

The new type calendar was not adopted in England and her colonies until the 18th century. By that time eleven days had to be dropped to bring the calendar in line. The new calendar was recognized in China and Russia early this century, at which time the two calendars differed by 13 days.

THE BACKBONE OF CLEAR THINKING

DAVID SKOLNIK AND AARON GOFF
Central High School, Newark, New Jersey

Teachers who take seriously the aim of guiding students to think have often wondered whether the thinking process has real form and structure. From the vagueness that shrouds this phase of the school program, many have come to regard thinking as a shapeless and intangible substance which dissolves into thin air on being approached. This attitude is probably the result of futile attempts to tackle thinking apart from its inner skeleton. We feel that the thinking process can be perceived by the average individual only when it is joined with its internal core. Because science and mathematics are concerned essentially with deductions and inferences, they contain a suitable backbone to which the thinking process may be attached for dissection and study.

More concretely, this means that science and mathematics individually, but more effectively in a joint effort, can teach students to think. No one, we hope, will interpret this to mean that every individual can be taught to think as easily as he can be taught to understand the principle that a limiting factor to life is light. Because of the inherent complexity of the thinking process, the degree of achievement must of necessity be commensurate with the mental ability of the learner. For the average student, however, improvement in thinking may be expected to result from a planned program of stimulation. Furthermore, we do not maintain that science and mathematics are the only subjects which can teach thinking but we contend that our subjects can contribute to this end in an unusually high degree.

Within these limitations, therefore, it may be expected that many will agree that the aim of teaching thinking through science and mathematics is laudable and possible of fulfillment. Few, however, will hold that this aim is now being realized. Still fewer, perhaps, would agree on why we have failed in this respect and what we should do to succeed. At the risk of stirring up a hornet's nest, we shall attempt to suggest some answers.

One of the obstructions in our path of establishing standards of thinking is the overloading of our subjects with required fragmentary facts. The science teacher often considers his prime objective a set of principles which he must get across, however detached and isolated they may be. Similarly, the mathematics teacher usually regards his subject as a closely knit unit in which he must cover a minimum number of algebraic processes or geometric propositions.

The net result is that the thinking underlying these principles and processes dwindles and disappears among a host of mechanical details, emerging only as occasional theoretical discussions in teachers' rooms or in professional journals.

Another obvious deterrent to emphasizing the thought process is the compartmentalization of subject matter. Regardless of the potentialities of a given subject for broadening the mental outlook of the student, the fact remains that real thinking transcends subject matter. With the organization of the subjects into blocks, the student, who is our ultimate goal, may be lost in the crevices. The solution to this difficulty does not necessarily entail the complete integration of the curriculum but it does imply a willingness on the part of the teacher to go out of his "assigned" territory and bring in whatever he can find in the pupils' experiences which will help him to develop a well-rounded pattern of thinking. This is not now generally being done. Even in two closely allied subjects like physics and mathematics the principle of correlation is usually ignored. Contending that his students have not learned or have forgotten certain facts in science, the mathematics teacher does not take time to use them even when they illustrate perfectly mathematical principles. The science teacher, on the other hand, often claims that his students "don't know math." Consequently, he avoids using it and sometimes even prides himself on his ability to teach his subject without the aid of mathematics.

Probably the greatest impediment to the teaching of thinking is the failure on the part of teachers to agree on the nature of thinking. Whether the science teacher accepts the ten imperative needs of the Educational Policies Commission, or he uses the Forty-sixth Yearbook of the National Society for the Study of Education, or he refers to some other list of accepted objectives, he finds that there is one universally approved goal of science teaching. This broad and ambitious aim is competence in the use of the scientific method for solving problems. To some this is critical thinking, to others reflective thinking, to many inductive thinking, and to all, more or less vaguely, the application of the scientific method. The mathematics teacher will similarly find that a pervasive goal of his subject is the establishment of a generalized mode of thinking. However, both the science and mathematics teachers find tantalizing evasions in the definition of these broader objectives and an almost complete absence of the means of implementing them.

Some psychological definitions of the thinking process are either too involved to admit of easy application or so brief as to be ambiguous. To some teachers the process does not follow a definite pattern. To some it does not even include a necessary goal but is more or less

haphazard. As in a sweepstake, the participant may reap a sudden reward like the ideas which came with Newton's falling apple, Archimedes' "Eureka," or Kekule's benzene rings in the smoke of the fireplace. To others the scientific method is the sum total of all thinking. Still others are convinced that, whatever the nature of the thinking process, mental efficiency gained in one field is automatically transferred to others. Thus, depending on their ways of regarding the thought process, teachers advocate different principles of pedagogy. Happily, only a few now sponsor the teaching of students *what* to think. Most instructors would teach their students *how* to think—if they could determine how to do the teaching. Some, however, feel that all that is needed is to make the student *think*. Although the analogy may not be valid, this would appear like throwing a person into the water and expecting him to swim before he has learned how.

Another major factor responsible for the neglect of the larger aspects of science and mathematics in the school program is the paucity of textbooks with that aim. With the heavy loads that teachers must carry, it would be unrealistic to expect them to work up suitable materials for broadening the intrinsic thinking in their subjects. One reason for the lack of adequate textbooks is of course the relatively small demand for them. A more important factor is the difficulty of preparing such books. If the material is to be practical and teachable it must undergo extensive testing under actual classroom conditions, since the guide of precedent is lacking. Another difficulty centers about the fact that teachers are accustomed to test their students on all the topics covered in the book. It is extremely difficult to devise materials of a really broad nature which will yield to a paper-and-pencil test.

Having indicated some obstacles in the way of making science and mathematics functional in general thinking, we will next consider these hindrances with the view of eliminating them and substituting some things more constructive. We begin with the absence of universal agreement on the essence of thinking. The idea that thinking is haphazard is to us an unthinkable hypothesis. The corollaries to such an assumption would be nihilistic and destructive. The ability to think would become the exclusive property of the scintillating and brilliant few but unattainable by the average. In place of this aimlessness we would postulate that an important objective of education is to make the pupil conscious of the fact that general thinking involves certain patterns which, to a varying degree, are accessible to him. The elements of science and, even more so of mathematics, are simple and clear-cut. They are usually divorced from human emotions. This enables the student to examine them dispassionately

and readily grasp the thought pattern. If science and mathematics are to integrate the thinking of the student, they must concern themselves more with generalized concepts than with isolated facts. No useful purpose is served by reviving the old issue of the transfer of mental efficiency. However, the very nature of generalization and abstraction is such that when a concept has been generalized transfer has already taken place.

The deductions and inferences which comprise the process of thinking are usually divided into two broad patterns, the inductive and the deductive. The former flow from particular cases tending to become more general; the latter seek to apply broad and universal propositions to particular situations. Traditionally, the inductive pattern has been the province of science whereas mathematics is usually considered a deductive study. This superficial division into "spheres of influence" is thwarted by the stubborn and disruptive reality that practical thinking is nearly always a combination of both patterns and their many ramifications. It must therefore be clear that neither science nor mathematics can establish a really useful mode of thinking so long as it restricts itself to a segment of the thinking process.

Some science teachers have appropriated the inductive method and have restricted themselves to it. The result has been that this so-called scientific method has deteriorated into a stereotype. The easy phraseology of some textbook writers has given the uncritical reader a picture of scientific discovery by formula. To a certain extent such formulas have a degree of validity. The fault lies in the promulgation of such methods as unqualified and attainable objectives of our present science teaching on the secondary-school level. This is accentuated when the scientific method is further stereotyped into the famous "six-step" method, beginning with "stating the problem" and ending with "verifying the solution."

For the most part, mathematics teachers are perfectly willing to leave the inductive method in the custody of science. They often dwell on the superiority of the deductive method (in the eminent domain of mathematics, of course) by contrasting the certainty of its conclusions with the tentativeness of the inductive method. If the thinking process were regarded as a whole, such comparisons would be ludicrous. The teacher who is interested in promoting clear and coherent thinking will explore both fields, and even "foreign" territory, with the aim of hewing a broad road for the intercommunication of ideas. If science is not to become a series of mechanical experiments in the eyes of the student and mathematics is not to become a string of vapid generalities, then each must have some-

thing of the other and both must reach out beyond their factual confines.

The overloading of science and mathematics with facts would almost automatically be remedied if the objectives of teaching these subjects were re-oriented. Once the underlying thinking became a major aim, the subject matter would be reorganized on that basis rather than according to the factual content. If this seems a bit far-fetched, let us see what the Harvard Report on *General Education in a Free Society* states:

> "The sciences are the preeminent field for logical studies, for practice in strict definition and the analysis of implication, for the dissection of misconceptions, for the remorseless exposure of false and irrelevant ideas encysted in parroted phrases, and for the discharge of morbid matter. It is the duty of the science teacher to help the student (in collaboration with the English teacher) to see and remember clearly the difference between the rigid terms of science and the fluid language of literature and conversation, and to protect him from the misplaced technical jargon which is a dry rot in so much current talk and writing."

On the college level we see an attack on this problem being pursued by Conant and his colleagues through the historical approach, notably in the series *On Understanding Science*. Perhaps an appreciation of the scientific method and the acquisition of its skills may be obtained through a detailed study of the great experiments of the scientific giants of history. However, we on the secondary-school level cannot as yet teach the history of science without some foundation of knowledge and vocabulary. We must therefore address ourselves to the more prosaic problem of teaching a variety of facts and principles which will apply more directly to the personal, social, economic, industrial, and political lives of our students. This brings us to the matter of procuring suitable materials for this purpose.

It seems to us that a recent textbook in plane geometry[1] may contain some clues for new courses of study and textbooks in science. From it we learn that such textbooks are more effective when organized so that the thinking process stands out prominently. Each unit should contain subject matter appropriate to the development of a given type or aspect of thinking. Since no one subject covers the complete range of thinking, the book should go into related fields, much as a manufacturer imports foreign ingredients needed in the making of his product. The product in this case is a generalized mode of thinking capable of wide application. The following example from this geometry may interest the science teacher who would enlarge the influence of his teaching beyond his subject matter.

The topic of *Induction and Deduction* is developed in a unit dealing with congruent triangles. Replacing the cumbersome and question-

[1] *Dynamic Plane Geometry*, by Skolnik. Reviewed in SCHOOL SCIENCE AND MATHEMATICS, June, 1951.

able proofs by superposition, the inductive method is used to show that two triangles which agree in three consecutive parts (s.a.s. or a.s.a.) are congruent. The remaining propositions about the congruency of triangles are easily established deductively. The importance of this treatment is the major emphasis which is laid on the inductive and the deductive patterns of thinking and their interrelationships. This is illustrated in the following problem.

"(a) Change 1/17 to a decimal, carrying the long division to 15 places. Does the decimal repeat?

"(b) Reasoning by induction, would you say that the decimal will repeat if carried far enough?

"(c) Can you reason by deduction that the decimal must repeat after a maximum number of places?"

In part (b) of this problem the student is of course led to reason inductively that the decimal will probably not repeat. In part (c) however, he may be led deductively to the opposite conclusion. The principle underlying the deduction is that the decimal will begin to repeat as soon as one of the remainders in the division is the same as one which was previously encountered. Since there can be only 16 remainders different from one another (each remainder must be less than the divisor 17), it follows that the decimal must begin to repeat after running at most 16 places. This is no attempt to establish the superiority of one method over the other but rather to drive home the characteristics of each. It points up the inherent danger in the inductive method of jumping at conclusions from insufficient evidence. Similarly, it makes clear the shortcoming of the deductive method which is the difficulty of "finding the handle"; in this case, the underlying principle about the 16 different remainders.

The following example extends the thinking of geometry beyond the subject matter—perhaps into social problems—by using what the pupil has learned about induction and deduction.

Prejudice means prejudging. A person is prejudiced toward or against something if he judges it before he knows all the facts about it. The opposite of prejudice is *suspended judgment*. Which form of thinking, inductive or deductive, makes greater use of suspended judgment? Give your reasons.

In the study of the method of *reductio ad absurdum*, the student is directed to cite (if not to perform) an experiment indirectly disproving the ancient theory that nature abhors a vacuum. This illustrates the use of scientific facts to give increased meaning to a type of thinking used in geometry.

Although the nature of demonstrative geometry makes it comparatively easy to broaden its basic thinking, we shall nevertheless suggest how science too can achieve similar generalizations. The ex-

amples which follow indicate how science teaching need not restrict itself to the inductive method. They illustrate inductions in the history of science. In each case empirical observations, methodical accumulation of data, statistics and calculations culminated inductively in an all-embracing generalization. Instead of stopping at this point, we suggest that science teaching go further and cite vital deductions from the generalizations—and do it so as to underscore the basic thinking.

Induction: The planets move in elliptical orbits. *Deduction:* The determination of the positions of the planets.

Induction: Two objects attract each other with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. *Deduction:* The determination of the weights of the planets.

Induction: Plastic materials and fibers are polymers of organic molecules. *Deduction:* The discovery of nylon.

Induction: Properties of elements are periodic functions of their atomic weights. *Deduction:* The search for and the discovery of gallium.

Such examples may be multiplied to show that truly scientific thinking is both inductive and deductive. The following examples suggest the possible impact of scientific thinking on life situations.

Induction: The result of statistical, biological and psychological studies indicates that all races or stocks of mankind are essentially the same. *Deduction:* The rejection of the doctrine of racial superiority.

Induction: Disease may be the result of any one or of several factors such as malnutrition, endocrine imbalance, the presence of bacteria, psychological stress, heredity, air pressure, poisons, low resistance, et al. *Deduction:* The treatment of disease may involve single-action therapeutics or a multi-pronged attack requiring several different kinds of treatment, including some form of psychotherapy.

Induction: A study of advertisements reveals that they use the principle of conditioned response by introducing irrelevant but attractive materials such as famous names, glamorous personalities, scientific jargon, and smooth language. *Deduction:* The rejection of gibberish and "window dressing" in judging the merits of a product or an issue.

Induction: Biology teaches that going on in each organism are the processes vital to its existence. *Deduction:* Our democracy must use the educative process to build within its citizenry the forces which are adequate to its perpetuation.

There are many other kinds of opportunities for the science teacher to extend and generalize meanings which are normally confined to his

own field. We can hear some skeptics ask if this kind of teaching would not entail an abridgment of some scientific facts to make room for the correlations. While it is true that some facts may not be covered in the allotted time, it is equally evident that others will have gained broadened significance through the applications in other fields. Thus, the nature of a chemical element takes on added meaning and is more easily remembered when compared with prime numbers in mathematics or with some prime qualities which are usually considered the components of personality. The concept of a catalytic agent may likewise be compared with zero in the arabic numerals or with the effects on civilization of some great personalities in history.

Science teachers too frequently emphasize the scope of scientific achievement and concentrate on what science holds in store for the future. It seems to us that science teaching has an equal responsibility to view with alarm the dismal drag on progress caused by our medieval human relations. Our students should be taught to realize feelingly that if we ever came to use the same ingenuity and logic in our social organization as science has used in its advances, more misery and unhappiness would be eliminated than by the further progress of science alone.

As fanciful as some of our suggestions may appear now, we believe that when the time comes that the spiral of education really converges on the individual student, science and mathematics will provide most of the backbone and the hard core of his thinking.

FIND FOSSIL BONE OF LARGEST BIRD KNOWN

A fossil bone of the largest bird known to fly has been found in Nevada, Dr. Hildegarde Howard, chief curator of science at the Los Angeles County Museum reported here today.

A wrist bone, it belonged to a huge vulture that lived hundreds of thousands of years ago. The bird has been given the scientific name, *Teratornis incredibilis*, to indicate its incredible size. Its wingspread is believed to have been 16 or 17 feet.

A wrist bone is usually considered unimportant in figuring out what ancient birds were like by studying their fossils. The unusual size of this wrist bone, however, sets it apart from that of any other known birds, Dr. Howard states.

Furthermore, Dr. Howard says, the wrist bone clearly indicates that the bird from which it came was a flier. In the large running birds, such as the ostrich, the wing is reduced and none would have a wrist bone of such size.

The new super-size vulture is a cousin of the *Teratornis merriami*, the vulture that previously held the record of being the largest bird of flight known to science.

The wrist bone specimen is part of an assemblage of Quaternary mammals and birds collected from Smith Creek Cave in White Pine County, Nev., under the sponsorship of the Carnegie Institution of Washington. The Quaternary period includes the Recent epoch in which we now live and the Pleistocene epoch, which began about a million years ago. The wrist bone is the property of the California Institute of Technology.

A STUDY OF THE "DOUBLE TRACK" PROGRAM OF MATHEMATICS IN THE SECONDARY SCHOOLS OF KANSAS

KENNETH E. ANDERSON
University of Kansas, Lawrence, Kansas

AND

LYLE J. DIXON
Arkansas State College

INTRODUCTION

Many secondary schools today provide what is frequently called a "double track"[1] in mathematics. The National Council of Teachers of Mathematics and other educational groups have long considered ninth grade algebra suitable for some students but not for others. These other students have for the most part been placed in a course termed general mathematics. The educational objectives of the two courses, as well as the content, have differed. However, the question arises: Are students who have had only algebra superior in certain testable areas to those who have had only general mathematics?

If the groups to be compared are tested at the end of the ninth grade, the enthusiasm of the teacher or teachers for algebra or general mathematics coupled with differences in academic preparation of the teachers, may favor one group of students or the other. However, if the groups to be compared are tested during the senior year, teacher differences in enthusiasm or academic preparation will be minimized. In other words, the test will measure to a large degree the retention of mathematical knowledge after a lapse of three years. In addition, the intelligence of the two groups being compared may differ considerably. If this is the case, the comparison calls for matching the groups on the basis of intelligence or controlling the differences statistically by means of analysis of variance and covariance.

STATEMENT OF PROBLEM

Did a sample of high school seniors who had taken ninth grade algebra achieve more on a standardized examination than a sample of high school seniors who had taken only ninth grade general mathematics, when the intelligence quotients were held constant? This statement of the problem was translated into a null hypothesis. The task then became one of rejecting or failing to reject the null hypothesis.

[1] The "double track" is described in a report of the Commission on Post-War Plans of the National Council of Teachers of Mathematics. This report appeared in the *Mathematics Teacher* for May, 1945.

The Sample and Examinations Used

In order to test this null hypothesis, a sample of forty-six students was obtained consisting of: (a) the twenty-three seniors who had taken only ninth grade algebra, and (b) the twenty-three seniors who had taken only ninth grade general mathematics. These students were seniors in one of forty-nine representative Kansas schools that had administered the *Essential High School Content Battery*[2] together with the *Terman-McNemar Test of Mental Ability*.[3] Thus, this investigation constitutes only a pilot study of the larger study now underway involving all of the forty-nine schools.

The mathematics test of the *Essential High School Content Battery* consists of sixty-six items testing the following areas:

1. Fundamental skills in computation.
2. Vocabulary and concepts.
3. Understanding of functional relationships.
4. Application of mathematics to life problems.
5. Interpretation of mathematical graphs.
6. Knowledge of mathematical facts and formulas.
7. Interpretation of data in tabular form.
8. Knowledge of important theorems.

Statistical Considerations

The statistical tool used to compare the two groups was the analysis of variance and covariance technique. All the assumptions basic to the use of this tool were met. The results of the calculations are given in Table I.

Table I. Analysis of Variance and Covariance, Scores on the Mathematics Test of the Essential High School Content Battery with Terman-McNemar I.Q.'s Held Constant

Sources of Variation	d.f.	S.S.	M.S.	F	Hypothesis
Within	43	760.33	17.68		
Between	1	.90	.90	.05	Not Rejected
Total	44	761.23			

Conclusions

The results given in Table I permit the conclusion: that on the average, the two groups of senior students did not differ in mathematical achievement as measured when intelligence was held constant. A comparison of the correct responses to the sixty-six test items as given in Table II indicates that the test was "fair" to both

[2] *Essential High School Content Battery*, World Book Company, Yonkers-on-Hudson, New York, 1951.
[3] *Terman-McNemar Test of Mental Ability*, World Book Company, Yonkers-on-Hudson, New York, 1941.

groups. No single question, or group of questions, appears to be unduly slanted in favor of one group or the other.

TABLE II. AN ANALYSIS OF CORRECT RESPONSES TO THE SIXTY-SIX TEST ITEMS IN THE MATHEMATICS TEST OF THE ESSENTIAL HIGH SCHOOL CONTENT BATTERY

Test Item	Number of Correct Responses		Test Item	Number of Correct Responses	
	Algebra Group	Gen. Math. Group		Algebra Group	Gen. Math. Group
1	17	14	34	7	11
2	8	13	35	7	7
3	12	13	36	18	21
4	13	6	37	10	8
5	8	7	38	5	14
6	5	3	39	6	8
7	5	9	40	5	2
8	3	6	41	1	9
9	12	7	42	9	9
10	7	6	43	4	4
11	6	4	44	8	16
12	6	6	45	6	13
13	4	1	46	8	9
14	1	0	47	1	2
15	1	3	48	1	3
16	3	5	49	5	4
17	4	2	50	6	10
18	2	0	51	4	4
19	5	5	52	1	2
20	7	5	53	2	2
21	14	15	54	2	1
22	20	22	55	1	6
23	11	8	56	4	2
24	8	5	57	2	6
25	2	7	58	3	1
26	9	6	59	7	6
27	2	3	60	4	2
28	9	5	61	7	0
29	20	19	62	2	3
30	14	13	63	4	2
31	11	13	64	3	3
32	10	11	65	2	0
33	10	12	66	4	3

EDUCATIONAL IMPLICATIONS

With due regard to the fact that this is a pilot study and noting further that the particular school chosen may not be representative of all the Kansas high schools, it seems desirable to point out some implications for our mathematical program on the secondary level.

Although the "double track" program for any one student does not necessarily end with algebra or general mathematics, it might

be implied from the findings of this study that the "double track" program is not meeting the desired objectives, particularly if the objectives of algebra and general mathematics are, more of less, mutually exclusive. The facts presented imply that the two groups of senior students retained approximately the same amount and kind of mathematical knowledge. It appears that the two short "tracks" (algebra and general mathematics) represented in this study are converging to the same "depot." The Commission on Post-War Plans of the National Council of Teachers of Mathematics certainly did not have this in mind when they made their recommendations. If the present study indicates the current status of our mathematics program on the ninth grade level, then the mathematics program is in need of re-appraisal. Beckmann[4] concluded that:

"If we accept the competencies (of the Commission on Post-War Plans) as valid objectives for mathematics in the schools, then the low level of mathematical competency and the relatively small gains by ninth grade students enrolled in algebra and general mathematics in Nebraska, indicated by the scores on this test of mathematical literacy, point out that one or more of the following conditions apply:

1. That our present curriculum in mathematics is poorly planned and developed.
2. That the teaching of mathematics is poorly done in our schools, or
3. That the competencies as proposed by the Post-War Commission have not been accepted as valid objectives by those planning the curriculum of the schools."

The facts of the present study seem to imply that even though we offer different courses, and often these same courses constitute the only training received in mathematics for a considerable number of students, the end product is the same. If this be true, why continue the dual offering at the ninth grade level? Let us either adopt one or the other as our ninth grade program in mathematics. We are sure that those in mathematical education will not adopt our suggestion, and we would not adopt it ourselves. Yet, it seems necessary that we consider the issue and make some sort of decision and implement the decision with a course of action. It might well be that algebra constitutes a better preparation than general mathematics for the traditional courses to follow in many school systems. However, an examination of the literature reveals that little research has been done on this particular problem. A great deal more is needed before any gross generalization can be attempted. The tools are available, waiting for eager and interested hands to put them to work.

[4] Milton W. Beckmann. "The Level of Mathematical Competency and Relative Gains in Competency of Pupils Enrolled in Algebra and General Mathematics." Doctoral Dissertation, University of Nebraska, 1951.

Postage Stamps were first used in the United States on March 3, 1847.

THE HIGH SCHOOL PHYSICS LABORATORY MANUAL

JOSEPH A. MACK
McBride High School, St. Louis 13, Mo.

(*Concluded from October*)

On the part of the student several factors enter into the time requirement of every experiment: (1) the student's eagerness to work rapidly and accurately, and to achieve comprehension; (2) his intelligence; (3) his experiences in similar situations; (4) his skill, or the lack of it, in manipulating apparatus; (5) the degree of accuracy required by the teacher or by the experiment; (6) the laboratory report—whether it is to be finished in or out of class.

On the part of the teacher other factors may be introduced: (1) whether he is maintaining the *even front policy* where the slowest student sets the pace for the classs; (2) whether the *contract policy* prevails, which gives a partial credit or mark for each part completed; (3) the time required for distribution and for gathering the apparatus; (4) the amount of the teacher's supervision which facilitates student progress.

Other factors are inherent in the experiment itself: (1) the complexity of the apparatus and the time required for its assembly; (2) the very nature of the experiment may be based on time measurements. Thus no single factor or even group of factors alone can determine the time requirement.

Authors differ greatly in the amount of morcellation. Nearly fifteen hundred experiments were examined in this study to produce a morcellation figure of 1.35. An item count of over two thousand is the total cumulative frequency of the morcellation.

No amount of tabulation nor any frequency count can of itself establish the time requirement for all experiments. But an answer may be deduced by inference from authors' content. Why would an author introduce two parts into an experiment when one is enough? Is it just to give an alternate procedure?

Except for those authors who deviate greatly from a 65–72 title count, we may expect that drawing from their own experiences as well as from that of their colleagues, the proposed work will be adequate for one laboratory period, such as they are found at present, 60 to 90 minutes.

Due to the inequalities in the tabulations of frequency of mention for experimental titles, a straight line choice cannot be made across the frequency table. If this were done the total inclusion of titles is

the desired number seventy-two. But this method of selection weights some sections out of due proportion. These proportions have been established by another frequency count.

Bearing in mind that some choice should be allowed to the instructor in the selection of titles with an eye to local factors of expense, utility and needs, the seventy-two count seems preferable to any other, especially where the two-per-week practice prevails. Two alternatives seem feasible. Limit the sections by an even front count till seventy-two is reached, or limit the inclusions by an equal increment based on per cent.

TABLE 6. PHYSICS LABORATORY EXPERIMENTS

	Present—Actual			Proposed			
Sections	Range	Mean	By %	Cum. fr. Twelve	By %	Adjusted	By %
Mech.	18–31	25.1	39	23	32	27	37.5
Heat	5–15	8.4	13	10	14	9	12.5
Elect.	9–26	19.1	29	25	35	22	30.5
Sound	1– 6	3.3	5	4	5	4	5.5
Light	4–17	9.1	14	10	14	10	14.0
Totals	39–94	65.2	100	72	100	72	100.0

These adjusted figures make the deviation from the item count ratio a negligible quantity.

For a justifiable selection of titles both morcellation and coalescence must go into action, parts must be combined at one place while elsewhere a title must be separated into two or more experiments, e.g., Buoyancy and Law of Flotation make but one experiment; the Voltaic Cell as also Resistance measurements must be divided into two or more experiments.

When the low count items of six or less mentions which have nothing to recommend their inclusion are dropped, two hundred titles, the lowest decile are cut from the List of Experiments. Cause for inclusion of a low count item might be the mention "basic" or Teacher Demonstrated type.

LIST OF EXPERIMENTS

A, qualitative; P, quantitative; number of mention: D, Teacher Demonstrated: *, Required.

MECHANICS—FORCE—MOTION

Measurement of Length, metric, A-17-*
Vernier calipers, A-9
Micrometer calipers, A-11
Volume, metric, solids, calculated, P-11
liquids, A-6
Weight, metric, A-7
Density, rectangular solids, P-19-*6
cylinders and spheres, P-10

Straight Levers—Principle of Moment, P
first class, -21-*8
second class, -10
third class, -10
Weight of Lever—Center of Gravity, P-17-*6
stability of airplane, A-2-D
Parallel Forces—Moments, P-18-*4
Wheel and Axle, P-15-*
Pulleys, P-20-*
Inclined Plane, P-20-*7
Mechanical Advantage, various machines, P-6-*
Sliding Friction—Coefficient, P
horizontal, -16-*
inclined plane, -11
Efficiency of Machines, P
block and tackle, -9-D
jackscrew, -7-D
inclined plane, -9-*
Liquid Pressure and Depth, A
floating test tube, -10
manometer submerged, -2-*
Buoyancy of Liquids, Archimedes' Principle, P-22-*5
Laws of Flotation, P-20-*2
Specific Gravity of Solids, P
displacement, sinkers, -22-*7
floaters, -18-*
Specific Gravity of Liquids, P
bottle, -19-*7
displacement, -14
hydrometer, -18
Atmospheric Pressure, A-17-D
seven variations
Mercury Barometer, A-D
straight tube with stopcock, -6
Fortin type, -3
Siphon, A-9
Density of Air, evacuated flask, P-9-D
Surface Tension, various, A-5-*
Boyle's Law, P
flexible tube, -12
J tube, -13-*5
Open Manometers, P
illuminating gas pressure, -10
lung pressure, -4
Bernoulli Principle and the Airplane, A-2-D
air pressure and the airplane, A-1-D
Breaking Strength of Wire, P-11
Hooke's Law, P
spiral spring, -22-*5
bending of rods, -5
Parallelogram of Forces, P-22-*7
Resolution of a Force—Crane Boom, P
horizontal, -15-*
at an angle, -6
Lift and Drag on a Model Airplane, P-2-D
Accelerated Motion, P
Duff's board, -3-*
Packard's inclined plane, -3
falling fork, -1-D-*
grooved inclined plane or wire, -3-D
collision pendulum, -2
Simple Pendulum, laws, P-*4
length, -17
mass, -15
amplitude, arc, -15
Velocity of Projectile, spring gun, P-1-D
Action and Reaction, spring gun, P-1-D
Gravity Constant, P
simple pendulum, -5
Whiting's pendulum, -1-D
Centripetal Force, P-2-D
Potential and Kinetic Energy, P-3-D

HEAT

Fixed Points of a Thermometer, A-21-*
increase b.p. with increased pressure, P-11
making a thermometer, A-1-*
Heat Transmission, A
three methods, -5
cooling by radiation, cooling curve, -5
heat insulators, -1-*
Linear Expansion of a Solid, coefficient, P-*5
lever type, -17
Cowan's form, -10
Cubical Expansion of Gas—Charles' Law
Waterman tube, P-12
Heat Exchange Law—Method of Mixtures, P-7
Specific Heat, P-21-*5
Cooling through the Melting Point, A-15-*3
Heat of Fusion, P-20-*4
Heat of Vaporization, P-20-*4
Dew Point—Relative Humidity, P
vapor film, -21-*2
wet-dry bulb hygrometer, -15
cooling by evaporation and solution, A-10
meteorological observations, A-1-D
weather maps and long range prediction, A-1-D
Heat of Combustion of a Gas, P-1-D
efficiency of a gas stove, P-5-D
Mechanical Equivalent of Heat, tube and shot, P-2-*

ELECTRICITY AND MAGNETISM

Properties and Laws of Magnets, A-14-*2
Magnetic Lines of Force, A
  iron filings, -21-*5
  exploratory compass, -11
Static Electricity, A-9-D
Voltaic Cell, A-*
  open and closed circuit, amalgamation, -22
  polarization, -16
  size and distance of plates, -10
  different metals and electrolytes, -10
  dry cell, -7
  Daniell cell, -5-*3
  internal resistance, -7
  grouping of cells, -17
Resistance Measurements, P
  Ohm's Law, -16-*4
  laws of resistance, -12-*
  temperature effect, -10
  series and parallel, -19-*5
  Wheatstone's bridge, -18-*3
Voltage Drop, P-*
  equal resistances, -3
  different resistances, -3
  current in the circuit, -4
  A.C. line drop, -3-*
Magnetic Effects of a Current, A
  single wire, -20-*6
  coil, core, and turns, -20
  electric bell and circuits, -17-*3
  telegraph sounder and relay, -7
Chemical Effects of a Current, A and P
  electrolysis of water, -7-*
  electroplating, copper, etc., -15-*2
  storage cell, -6-*
  copper coulombmeter, -6-*
  rectifiers, -3-D
Heat Effect—Joule's Law, P-13-*3
  efficiency of an electric stove, P-6-D
Induced Currents—Lenz's Law, A
  moving coil or moving magnet, -22-*6
  electromagnetic induction, coil to coil, -16
  transformer on A.C., -2-D
Electric Generators, A-*5
  magneto, -13
  direct current, -15
D.C. Electric Motors, A-*5
  permanent magnets, -19
  series or shunt wound, -17
Cost of Power in Electricity, P-21-*4-D
Efficiency of an Electric Motor, P-11-*-D
Impedance—Reactance, P-D
  inductive, -5
  capacitative, -3
  power factor, -2
  resonant circuit, -1
Characteristics of a Vacuum Tube, P-17
Audio Oscillators, four variations, A-*
V.T. Amplification-Rectification, A-*
  four variations, -4
  radio receiver controls, -2-D
Photo-electric Cell, A-1-D

SOUND

Frequency of a Tuning Fork, P-16
Wavelength—Velocity of Sound in Air, P-*5
  resonant closed tube, -21
  direct measurement, -6-D
Resonant Air Columns, P
  open tube, -5
  closed tube, -5
Velocity of Sound in Metal, P-D
  Kundt tube, -2
  direct measurement, -1
Pitch and Music, siren disk, P-1-D
Laws of Vibrating Strings, P-*
  length, -19
  tension, -19
  mass per unit length, -7
  harmonics, -1
Laws of Pipes, P-1-D

LIGHT

Illumination Measurement, Foot-candle meter, A-4-D
Photometry, Bunsen, Joly, Rumford, P-20-*5
Plane Mirror—Laws of Reflection, A-17-*3
  images
Curved Mirrors, P-*2
  convex cylinder, -9
  concave cylinder, -8
  convex spherical, -5
  concave spherical, -12
Refraction of Light—Index, P-*4
  rectangular glass block, -22
  glass prism, -9
  water, -2
Critical Angle, A-4-*
Focal Length of a Lens, A-22-*4
  direct measurement
Converging Lens,
  images, A-14
  conjugate foci, P-17-*4
Photographic Camera, A-3-D
Magnifying Power of a Lens, P-13
Compound Microscope, P-20-*
Astronomical Telescope, P-19-*
Dispersion—Color, A-8
Wavelength of Light, P-2-*

PART II. OVERAGE PHYSICS LABORATORY MANUALS

The secondary purpose of this investigation is the survey of out-of-print and overage physics manuals published during the period 1900 to 1930, (1) to find what experiments have been discarded in the manuals of more recent copyright date, or in the revisions of the older ones, and the probable reason for this action. (2) to discover trends in the laboratory experiments: toward less difficult ones; toward the appreciation type rather than those involving mathematical calculations; toward a greater number of student-operated experiments.

Concordance

Among the overage group, 1900–1930, there is a high correlation among the titles of the twelve authors with about the same deviation as there is in the more recent manuals.

Between the overage group and the more recent 1930–1950 group there is such a high correlation of titles, that if the tabulation sheets did not identify to which series they belonged, they might be thought to belong to either group.

Changes in the Revisions

Most manuals underwent at least one revision. The revisions in some cases differ only from the originals by no more than a change in format, e.g., the size of the page, or the substitution of line drawings for the less clear photographic illustrations. In the case of the consumable manual with detachable pages, the change at times consists only of the insertion of a sheet or two of graph paper and of several blank pages for drawings. Still in other instances the changes in the revisions are profound, such as the deletion of experiments, the modification of retained ones, or the introduction of new ones. The sequential rearrangement in revisions is at times a distinct improvement. In this study the point of interest was the deletion of older experiments or the inclusion of newer ones.

One notable weakness in the overage manuals is that of duplication, where the first of two consecutive experiments requires only qualitative results while the one immediately following it requires quantitative results in the treatment of student observations.

We can easily distinguish alternate procedures when the author lists parts as *A* and *B*, or the second one as *optional*. But at times it is not clear whether one part is of a qualitative type experiment and the second part a quantitative one. The degree of accuracy expected is rarely mentioned.

Possibly the greatest change from the overage manual to the more recent one is the deletion of numerical problems which formerly

were appended to experiment,—problems which did not result from student investigation. These problems, while cognate to the experiment seem to be introduced solely to fill out the time of the laboratory period.

Manuals copyrighted during the first decade of the century are heavily weighted with the appreciation type experiments. In sharp contrast is a manual with a copyright date of 1913 which consists almost exclusively of the quantitative experiments. One wonders, realizing the scarcity of apparatus and equipment in the first and second decade of the century in every laboratory, just how many of such experiments were not teacher demonstrated.

One author regularly gave two procedures, but just as regularly listed the second one as optional. It is impossible from such a listing alone to determine whether this author meant the first part to be used as one-period laboratory work and the optional part for the double laboratory period, or whether the optional part was strictly to be taken as an alternate procedure.

Trends

Two popular laboratory manuals, so adjudged by their perdurance to 1951, appeared early in the century, 1906 and 1913. These manuals are still in vogue in their revisions. There have been two revisions in one and three in the other. In them one can follow the trends over the last forty years.

Two opposite trends are very evident from the details of the tabulations. Greater morcellation is found in the manual by one author, i.e., the number of titles increased with each revision, though few new procedures were added.

A contrary trend appears in the other author's manual toward greater coalescence. But the added experiments still keep the total number of titles the same. Both manuals began with about fifty experiments and in the first revision increased this number to about sixty-five, and this number appeared also in the second revision.

A manual by several authors which appeared during the first decade of the century went through two revisions. These revisions made profound changes in it, yet there always remained throughout the revisions one characteristic of the first edition, namely, that the ratio of quantitative to qualitative experiments was two to one in favor of the former. Nevertheless, this same manual has an electricity section which is preponderantly of the qualitative type experiment.

In general it can be said that better sequence of titles developed with the years. The manuals showed a better appearance as line drawings improved. It is certain that the ideas of the authors clarified with the lapse of time, whether as a result of their own thinking or

at the suggestions of many unrecognized and unidentified teacher colleagues. The modern manual is clearly the result of earlier editions.

At times the overage group has procedures different from the modern group, or in a multi-sectioned experiment there may be one procedure which is no longer used in the more recent editions. To determine the lost titles over the decades, a mention of one was necessary for a title which could not be found in the 1930–1950 group.

EXPERIMENTS ELIMINATED IN THE REVISIONS

Mechanics

Comparison of English and Metric Units
Diameter of Capillary Tubes
Density of Liquids by Manometer
Density of Liquids by Constant Volume Hydrometer
Density of Floaters—Ratio of Part Submerged
Lever Arm of Non-parallel Forces
Molecular Constitution of Matter—Alcohol Water Mixture
Formation of Drops
Accuracy of a Bourdon Gauge
Aneroid Barometer as Altimeter
Water Motor Efficiency
Differential Pulley
Model Roof Truss
Model Bridge Truss
Centrifugal Force
Boyle's Law—Straight Tube
Calibration of a Spring Balance
Length of a Second Pendulum—Coincidence Pendulum
Acceleration—Atwood's Machine
Work Done by a Pile Driver
Newton's Laws of Motion
Momentum

Heat

Efficiency of Fuels—Alcohol, Gas, Oil
Coefficient of Expansion of a Gas—Volume and Pressure
Coefficient of Expansion of Mercury
Melting Points
Boiling Points of Liquids
Specific Heat of a Liquid
Dew Point—Leroy Apparatus
Cooling Curve of Water
Freezing by Evaporation
Testing the Home Ice Chest
Vapor Pressure of Ether, Alcohol

Electricity

Magnetic Strength and Distribution
Lifting Strength of an Electromagnet
Tungar Rectifier Efficiency
Edison Storage Cell
Tangent Galvanometer Calibration
Transformer Efficiency—Core and Shell Types
Two Fluid Cells

Sound

Musical Tones
Overtones in Strings
Sympathetic Vibrations

Light

Law of Inverse Squares
Rotating a Mirror
Eye Testing
Measuring the Angle of a Prism
Focal Length by Parallax
Prisms
The Spectroscope

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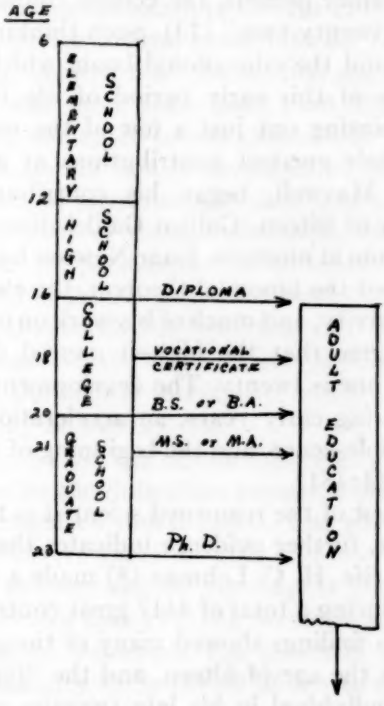
TOO MUCH EDUCATION

M. MANTELL
University of Miami, Coral Gables, Florida

Introduction. In the face of the many decrying the dire need for more education, the writer would like to present the thought that an excess of even those things which are generally good can be harmful—that there can be an excess of full-time formal education, and that we have possibly already reached the point of excess.

In the pages to follow some of the reasons will be presented to show why there may be need for a retrenchment and revision of our educational structure to one similar to that shown in the figure below.



In an article to follow it is hoped that it can be shown that such an educational structure is readily attainable with little loss and many gains. For the present there is herewith propounded the factors which indicate that we have "too much education."

Sociological Factors. In the early 1800's students were admitted to college as early as the age of ten years and were regularly admitted at the age of fourteen (3:35). In comparison, today's average college student enters at an age close to nineteen; and after spending four

years or more in earning his degree is generally required to serve a period corresponding to an apprenticeship before he can approach economic independence in his vocation or profession.

The problem of the rising age at which men can get prepared to go to college has been intermittently approached thru the years. Over fifty years ago President Eliot of Harvard spoke of the difficulties having to do with this age of college entrance which:

"has been rising for sixty years past and has now reached the extravagant limit of eighteen years and ten months. As a consequence the average college graduate who fitted himself for one of the learned professions could hardly begin to support himself before he was twenty-seven years old" (13).

In 1913 a committee of the National Education Association declared that "the period of general education is too long . . . with greater efficiency in the earlier periods, the college course may well end at twenty instead of twenty-two." (13). Such thinking was interrupted by World War I and the educational boom which followed.

The importance of this early period of life to society may be emphasized by pointing out just a few of the men of science who made many of their greatest contributions at an early age. The physicist, James Maxwell, began his contributions to scientific societies at the age of fifteen. Galileo Galilei discovered the isochronism of the pendulum at nineteen. Isaac Newton by the age of twenty-three had developed the binomial theorem, the elements of calculus, the principles of gravity, and much of his work on optics and color (5).

Psychologists agree that the highest mental development takes place by the time one is twenty. The development from birth shows a slow growth during early years, an acceleration from late childhood thru early adolescence, and the beginning of a gradual deceleration after sixteen (4:451).

The usual concept of the renowned scientist is that of a venerable old man. However, further evidence indicates that the prime age is the early years of life. H. C. Lehman (8) made a study of a total of 1264 workers producing a total of 4417 great contributions to science and literature. His findings showed many of the great contributions being made before the age of fifteen, and the "typical" outstanding scientist was an individual in his late twenties or early thirties at the time he was doing his most important work. Plotted curves of contributed works against age showed a sharp rise up to the peak period (28 to 32 years) and then almost as sharp a drop in contributions with age.

"Outstanding discoveries in science, finest books in literature, greatest inventions, all such accomplishments tend to be made by relatively young men. In short, it may be far more important than is ordinarily realized that a man be started in his life career early in his prime if his maximal potentialities are to be realized; and a few years delay may well be serious (12)."

It may be said that these individuals are genii or near genii and the exception will not prove the rule. It must be granted that these individuals were exceptional; however, had Newton and Galilei attended an engineering school of today, they would have been occupied sixty hours a week doing made problems and writing routine laboratory reports at the same age they were performing their greatest work. Even genius would have considerable difficulty salvaging much time, beyond the sixty hours, for creative work. In all probability had Newton and Galilei attended an engineering school of today they would have lock-stepped their way thru their most creative years—into obscurity.

The rising age of college graduates also apparently has been a major contributing factor to the gradual degeneration of our nation thru heredity. A study at Mississippi College (13) which very closely approached equal environmental conditions for the subjects, except for college training, showed that the median age of marriage of 604 college graduates was three years later than 591 brothers of these graduates who did not enter college. Statistical data (2:183) have indicated that the size of family decreases as the age of marriage increases. This train of circumstances has been borne out by F. L. Babcock's study (1:16) of college graduates showing the average size of family to be 3.2 persons compared to an average of all U.S. families of 4.0 persons. Although recent trends, since World War II, differ somewhat it is generally believed that this change is temporary and that long range trends indicate that a major portion of our population having the highest intelligence is not reproducing itself—leading to what may be race suicide.

The prolongation of the age of marriage also seems to be a major contributing factor to the difficulties presently being encountered in holding to our recognized moral codes. The average age of sexual maturity is about twelve years for girls and fourteen years for boys (4:52); while the average age for marriage is about twenty-two for girls and twenty-five for men (11:10). Society can hardly expect the average individual to overcome the powerful sexual drives and maintain sexual morality for a period of ten to eleven years before marriage.

"The moderate exercise of the sexual function, once maturity has been reached, undoubtedly contributes to the physical and mental balance of a man or woman; and from the physiological point of view, therefore, it would be desirable that sexual relations should be established soon after the completion of sexual development. In those countries where marriages take place at an early age, sexual activity commences soon after maturity. In our own social life, however, early sexual unions are usually not feasible. On one hand the social and economic conditions make early marriages impractical, and on the other, our moral, ethical, religious and legal standards prohibit sexual relations outside of wedlock. Thus a serious problem is created concerning one's sexual behavior during the interval

between the age of maturity and the age of marriage; a problem to which no socially sanctioned solution has as yet been found (14: 227)."

Marriage while in school has been suggested as a solution to this problem. Present evidence indicates that it is only a partial answer. Parents frown upon the teen-age marriage, perhaps partly out of fear that they may find themselves with additional mouths to feed. The young couples are usually at least partially dependent upon others; this often leads to insecurity and uncertainty which, combined with the many other problems of school life and the difficult adjustments of the early years of marriage, make success both in school work and in marital relations problematical. In a study (11:199) of 252 undergraduate marriages, only in 106 cases did both succeed in graduating and in most instances outside help was necessary. Earlier completion of full-time formal education would be far better in that it would tend to bring the ages of physical, social and economic maturity closer together.

Economic Factors. A shortening of full-time education may be expected to do much to raise our standard of living thru additional contributions to scientific and cultural progress during the prime age of each individual, by additional individual family income available thru a shortening of the period of required support of children, and thru the additional manpower available for the production of wealth.

Some will argue that with the increase of longevity the young people are not needed, will only put others out of work, and are therefore best kept in school longer. This argument is comparable to that advocated, in the early days of the machine age, to "destroy the machines" because they were putting people out of work. They wish, in effect, "to destroy youth" so people will not be put out of work.

With so much disease, floods, erosion, poverty, etc. existent in the world it is difficult to see where the young people, and any other source of manpower, could not be put to good use. The tasks to be done are ever present; it is not so much a problem for society to find how it may take up the idle time of youth as it is to see that they are given the opportunity to do the work that needs to be done.

Were it to be granted that our nation does have sufficient manpower, our young people could help bring about a shorter work week for all; or we could encourage earlier retirement of the older generation—this is probably not desirable, but certainly more so than an enforced unproductivity of our young people in the prime of life.

The vigor and idealism of youth is direly needed interspersed occasionally in positions of influence. There is little doubt that with

age one tends to lose his idealism—having had to compromise with life more often, it becomes easier to compromise when compromise is unwise. The longer one comes in contact with the same existing wrongs, the greater the possibility of thinking that they cannot be corrected (in one lifetime). With time, the wrongs may even appear justifiable. One of the largest international civic organizations, the Junior Chamber of Commerce, recognizes this in their constitution. They recognize that the majority of the senior members occupying the important offices of an organization will usually prevent or discourage any crusading youngster from "wasting his time trying to remake the world." The disastrous effect of the conservatism and lethargy which often comes with age is recognized by the Junior Chamber of Commerce as a principal cause of the ineffectiveness of most civic organizations, and therefore in their constitution they automatically exclude from office or voting membership all men over thirty-six years of age. Such an age limitation certainly would not be advisable in governmental affairs, but youth should be given greater opportunity to take part in the direction of our nation.

There are many who claim that industry does not want to hire immature young people. It is difficult to say how much immaturity is the result less of age than of environment and responsibility. Undoubtedly an employer would usually hire the older of two youthful applicants; but this would be primarily because the older applicant would probably have either or both more education and experience. The age of first employment has been rising steadily, but there is little evidence to indicate that employers will not hire college graduates at the age of eighteen to twenty when jobs are available. On the other hand a study (6) of the accomplishments of graduates of the School of Education of Ohio State University shows evidence to the contrary. Graduates at age nineteen and twenty were carefully matched by entrance records and cumulative point-hour ratio with students graduating at the usual age of twenty-two. A greater number of the younger graduates secured teaching positions immediately after graduation, more of them were able to secure top salaries in the teaching profession, and they outdid their elders in securing advanced degrees. Additional evidence is presented in a study (12) of 924 Amherst graduates who lived to over fifty years of age. It was found that a much greater percentage of the graduates of nineteen and twenty were nationally known and a smaller percentage were failures (in unskilled labor, not self-supporting, etc.) when compared to the older graduates.

Educational Factors. A shortening of full-time education will obviously raise the general level of educational attainment in that

the average student would complete additional grades in the same terminal period of time. There is growing sentiment to make education thru the fourteenth grade available in the same way that high school education is available now, as indicated in the report of the President's Commission on Higher Education (15:37). However, "free" public schools are free only in that there is no tuition; money is needed for transportation, board and lodging, extra clothing, school supplies, activities, etc. In spite of "free" education, according to a recent U.S. Census Bureau report, only 66.6 per cent of the sixteen to seventeen year old group were attending high school (16). Under a retrenched program these students might at least complete a high school education before dropping out due to economic or other reasons; and there would be a much greater possibility of giving the majority two years of college in the same length of time that it now takes to acquire a high school diploma.

There is much evidence that today's youth of fourteen to sixteen can handle college work as successfully as did the youth of the early 1800's. C. W. Odell's study (9), and others (7:83–86), (10), have shown that in most cases the students entering at these early ages make better scholastic records, and after the first term fit into the college routine much better than the older students. Most important of all is the fact that a much higher percentage of the younger students completed their college work.

Finally it is to be hoped that the development of a retrenched program would do much to dispel the altogether too common concept of "terminal" education. As long as people continue to endeavor to "complete" their education by obtaining the High School Diploma, Bachelor's degree, or even the Doctor of Philosophy, there must be dissatisfaction; and an inevitable trend towards greater and greater expansion of full-time education in the vain attempt to reach the ultimate. One of the basic principles of education should be a recognition that the learner cannot learn all that we should like him to know. Education must be a life-long process and the general lack of recognition of this in the educational goals and concepts presented to the students is one of the major failings of our present system. If our schools have not created the desire for further education after leaving school, they have indeed failed. The tendency to bind the student to his seat for an ever longer period, with legal, social and economic fetters, until he is "educated" may be checked by the reorientation that a change of the educational structure would bring about. There should be a transition, *at the optimum age*, from full-time education to an ever continuing educational program adapted to meet the needs of the individual while actively self-sufficient in society. The solution will ultimately lie in the realization of further

expansion of our rapidly growing programs of adult education. Someday we shall come to see that the nourishment of the mind and spirit, like the nourishment of the body, should be provided for throughout the whole of life.

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ABC HAS NEW EDITOR-IN-CHIEF

Dr. Everett T. Calvert has been appointed Editor-in-Chief of American Book Company as of September 1, 1952. Dr. Calvert, for the past eleven years Principal of Washington Elementary School, Pasadena, California, is a graduate of LaVerne College (A.B., 1931) and Yale University (Ph.D., 1942). A native of California, he has taught in one-teacher rural elementary and in urban high schools there, at the University of Southern California, and at Yale. His field is education, with specialization in curriculum, child development, and administration.

During the war Dr. Calvert served as Classification and Selection Officer in the U. S. Maritime Service at Catalina Island. From there, he transferred to the U. S. Marine Corps, serving as a First Lieutenant in the Far Eastern Theater, participating in combat service in the Philippines and at Okinawa.

In his new position, Dr. Calvert will succeed W. W. Livengood, of the editorial staff of American Book Company since 1912 and Editor-in-Chief since 1931. Mr. Livengood will assume new duties as Executive Assistant to the President.

Dr. Calvert will be located at the New York Office of American Book Company, 55 Fifth Avenue, New York 3, N. Y. after September 1.

Pure and applied science are the roots and the branches of the tree of experimental knowledge.—Norman Campbell: *What is Science?*

"CONSERVATION DAYS" AT SOUTHERN OREGON COLLEGE OF EDUCATION

H. SEYMOUR FOWLER
Southern Oregon College, Ashland, Oregon

As is the case in many of the Teachers' Colleges, Southern Oregon College of Education does not, as yet, present a regularly scheduled course in Conservation of Natural Resources. However, many of the instructors at the college are aware of a need for such training in the elementary teacher education curriculum and so spend a part of class time in presentation of materials related to conservation in their various fields. A small group of the faculty of Southern Oregon agreed that this was a good policy and should be continued but that this alone was not sufficient. Consequently this small group of faculty members met to determine ways of emphasizing conservation. As a result of preliminary meetings, plans for "Conservation Days" on campus were formulated. It is of importance to realize that even within a small Teachers' College faculty, one finds resistance and inertia toward developments such as this. In general, however, most Teachers' College faculty members are aware of the need for training in conservation and are anxious to be of assistance in bringing such training to their students. The committee formulating plans for this endeavor then enlisted assistance from those faculty members who were in favor of such a program. For example, members of the art department prepared posters and signs to be used in advertising. One of the members of the history department utilized a two-week period which included "Conservation Days" dates to present the historical development of the conservation movement. The economics classes discussed some of the economic problems arising as a result of failure to adopt conservation practices. The person in charge of publicity for the college was especially helpful in advertising the program both through radio and through newspapers. Members of methods classes studied means of presenting conservation concepts to the elementary school child. Freshman students from Science Survey courses, both biological and physical, participated in many of the sessions and then during the regular class periods, these students discussed their participation in these activities. In general most of the activities connected with "Conservation Days" received good student support. A suggestion is in order for those who might wish to undertake similar programs. It seems advisable to start early in any school year to make plans for a program such as "Conservation Days." In this way various instructors

would know far enough in advance so that they might include conservation topics in their classes at the appropriate time.

Our program at Southern Oregon College consisted of various activities. These will be described in what follows. An exhibit of free and inexpensive materials useful in presenting the conservation idea was prepared. These included printed materials made available by federal, state, and private agencies. In addition, a display of demonstrations and experiments using simple, inexpensive, improvised equipment was also included as a portion of the exhibit. The exhibit was open to the public and many teachers from surrounding communities attended. A large number of our college students were in attendance. The exhibit was open officially during one afternoon only. However, many classes attended at other times during the two-day period. Time during the regular class periods was devoted to this experience.

During the evening of the first day a meeting of interest to both townspeople and students was held. At this time the Assistant State Game Director of the Oregon State Game Commission discussed problems related to wildlife management. Also the functions of the Game Commission were described. At the end of the formal presentation, the meeting was open to discussion and questions from the audience. As a result of this meeting, our students became aware of a growing need for an understanding of game management problems on the part of the public. The Assistant Game Commissioner pointed out also numerous ways in which teachers might assist in this endeavor. The teachers also learned that members of the State Game Commission were ready to assist them in the development of conservation programs in their schools.

The program of the second day included a variety of activities related to conservation education. During the regular assembly period the students heard a speech by the Head of the Educational Relations Section of the Pacific Region, U. S. Soil Conservation Service. The speaker pointed out the relationship of man to his basic resource, the soil. In addition emphasis on the citizen's responsibility in relation to the resource was brought out. The work of the U. S. Soil Conservation Service in assisting the citizen to fulfill his responsibility to the resource was discussed. Our students gained much from this experience. The presence on campus of an authority in the field served to focus attention on the significance of soil conservation.

Since we believe that one of the most important methods in conservation education is field experience, we scheduled a field trip for the afternoon of the second day. Participation in the field trip was

entirely voluntary. At least one student representing one of some thirty different college classes was present. Each student who attended the field trip was required to make an oral report to the class which he represented.

Our location at Ashland is unique. The city proper is in a deep valley surrounded by mountains. The city of Ashland is dependent on the surrounding Douglas Fir-covered slopes for its water supply. A trip was planned, which would demonstrate this to our students. During the trip to the water-shed area we observed the forest-covered slopes, the water-absorbing duff layer, and the various species of trees and shrubs common to the area. The District Ranger who accompanied us pointed out evidences of the original forest type, evidences of logging in pioneer days, the value of shrubs as cover, demonstrated the use of the forester's increment borer, showed us "post-fire" species, and illustrated succession by showing areas which had been logged or burned at different times and had recovered. Also the class saw the effects of a closed canopy with its resultant natural pruning of the trees making up the canopy.

Our basic resource, soil, was not neglected. The local Soil Conservation Service representative participated in the field trip. Under his leadership the students were shown: the forest soil type, the effective soil depth, sheet erosion and erosion control measures. While coming down from the higher elevation to the valley below it was possible to observe a variety of soil types. In addition to soil and forests as a resource, our students saw numerous "signs of wildlife" among which were tracks, droppings, species of plants used as food by wildlife and evidence of browse. Throughout the field trip emphasis was placed on how the information given by the experts could be used by the elementary teacher in presenting the conservation story to boys and girls.

The final activity during the "Conservation Days" program was a panel discussion. The participants in the panel included the local game manager, the District Ranger, the local Soil Conservation Service District representative, a commercial forester, and three educators. The panel discussed the resources of southern Oregon in relation to their past and present utilization and the plans for assuring a continued supply in the future. The panel was open to the public.

The foregoing is an attempt to show one means by which a Teachers' College has brought the conservation story to its students. The program described is not purported to be the only method. Since it met with some degree of success, it is reported here in the hope that it may be of value to others who might be planning similar activities.

LET THEM DO IT THEMSELVES— SCIENCE THROUGH INDIVIDUAL PROJECTS

HELEN L. GILBERT
Tappan, New York

Jack, although a boy of extreme nervousness and afflicted with stammering stood before his class more than half an hour and demonstrated what he had learned about steam. His assurance, poise and understanding of his project were far in access of his ordinary below average class work.

Four of the boys after much reading and research discovered the need of a trip to the Museum of Natural History if they were to collect sufficient data for the mural on prehistoric animals. They were excused from school one day for this trip.

One class period was too short for the report from the group studying local fish and their habits. They had collected and preserved specimens from the nearby rivers and lakes which included shad, eel, brown trout, sucker, blue gill, yellow bass, pickerel, calico bass, cat fish, white perch and yellow perch. They prepared articles on the life of each of the specimens and concluded their report with an explanation of the game laws and the various types of fishing tackle which they had used.

Thus could go the report, group by group, for the twenty-five seventh graders who decided to develop individual and group projects in a formal departmentalized setting. Since this was an entirely new way of learning for them they spent some time developing a procedure for work. This involved an examination of the resources which were available and how they could be used effectively. They reviewed the scientific method of experimentation, and the value of good collections of well preserved specimens. During this period they chose an area which they wished to study and organized groups when several showed interest in the same area.

The first step for each group consisted of setting up the specific problems or objectives. With these in mind each group decided on the procedures to be used in solving their own problems. The techniques involved included the making of collections, study and examination of specimens, reading and research, painting of murals and preparation of charts, experimentation, field trips, interviews and museum trips.

The fifty minute class period was given over to this group activity for a period of several weeks and was followed by a time of sharing and evaluation of the various projects. This type of work necessitated a very informal arrangement of the room. The movable desks were

grouped according to the needs of the committees. The role of the teacher became that of consultant as she moved from group to group.

Some of the students needed very little assistance since they were able to organize their problems independently. Jack, working alone on the problem of steam, planned and prepared a set up to show how steam could travel through a series of radiators. He heated colored water in a flask and passed the steam through a series of bottles showing that steam carried none of the coloring matter and was invisible. To show how the horizontal movement of a piston was converted to circular motion he arranged a drive wheel and belt on a small steam engine. He demonstrated the purpose and importance of escape valves in using steam. To make the operation of the piston within the cylinder more vivid he prepared two large labeled diagrams and a small cardboard model of a cylinder and piston. He carried his interest into a study of steam locomotives and their development showing pictures of the progress. He arranged to board a locomotive and described the operation of the stoker, firebox and boiler as he had seen it.

Jane, a girl of extremely limited mental ability, required considerable individual attention in planning her activities. She studied plants and as a result exhibited a plant which had grown crooked in search of light. She exhibited plants for which she had records of the time of germination and rate of growth. Also included in her study were the parts of a flower and the making of food by green plants.

Jane needed help in organization while Arthur needed constant supervision. He studied light and eventually gave a satisfactory demonstration and report but his greatest gains were in learning to work independently and to keep at a task until it was completed.

Other areas chosen for study were acids and bases, health (involving a study of health conditions in our own school) reptiles, astronomy and electricity. Many of the values of the project method are intangible and may not be evidenced for some time. The conclusions of the class are perhaps the most accurate measure of the real value of this method of learning. These were the statements they outlined on the board on the day of final evaluation of individual projects and activities.

The Activity Period

1. It is fun and we learn more when we enjoy it.
2. Studying one project for a longer time helps us learn more about a particular subject.
3. We become more independent in planning, thinking, reading, and carrying out activities.

4. We are building good foundations for advanced work in high school.
5. We learn more when we do the activities for ourselves.
6. We learn to cooperate and work together on committees.
7. We have learned to get information from reading, observation, interviews, field trips, collections and experiments.

The Reporting

1. We learned many interesting facts from the reports of the others.
2. We learned to give accurate reports with specific examples.
3. We learned to prepare our exhibits and demonstrations ahead of time.
4. We learned that in giving the report it is necessary to speak loudly and clearly in a pleasant voice, to stand erect and to be sure of what you are going to say and do.
5. We learned that a good audience helps the committee to give a good report.

Listening to informative reports presented in a well organized manner and supplemented by explanatory activities was but to touch the surface of the growth of scientific information made by the pupils. The greater growth in poise, dependability, cooperation, organization and the use of the scientific method of thinking was evidenced throughout. So great were the gains from this first attempt that this procedure for individual projects in a departmental situation have been repeated with continued success.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed, Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

Late Solutions

2305. *Proposed by V. C. Bailey, Evansville, Ind.*

Show that the inradius of the triangle formed by the feet of the altitudes of any plane triangle, ABC, is given by formula $r=2R\cos A\cos B\cos C$, where R is radius of circumcircle of triangle ABC.

Solution by Leon Bankoff, Los Angeles, Calif.

The circumcircle of pedal triangle LMN is the nine-point circle of triangle ABC. If R_1 is the radius of the nine-point circle, it is known that $R_1=R/2$. We also know that the angles of the pedal triangle are $\pi-2A$, $\pi-2B$, $\pi-2C$ if A, B, and C are all acute. Applying a familiar relationship between the inradius and the circumradius of a triangle, we have

$$\begin{aligned} r&=4R_1\sin\frac{L}{2}\sin\frac{M}{2}\sin\frac{N}{2}\\ &=2R\sin(90^\circ-A)\sin(90^\circ-B)\sin(90^\circ-C)\\ &=2R\cos A\cos B\cos C \end{aligned}$$

If one of the angles, say A, of triangle ABC is obtuse, the angles of the pedal triangle are $2A-\pi$, $2B$, $2C$. Then,

$$\begin{aligned} r&=2R\sin(A-90^\circ)\sin B\sin C\\ &=-2R\cos A\sin B\sin C \end{aligned}$$

It should therefore be noted that the problem has been stated incorrectly.

Solutions were also offered by: C. W. Trigg, Los Angeles City College; Hugo Brandt, Chicago; A. R. Haynes, Tacoma, Wash.; Norman Kessner, Brooklyn; Richards H. Baker, Milford, N. Y.

2306. *Proposed by V. C. Bailey, Evansville, Ind.*

Find the limit as $x\to 0$ of

$$\frac{\sin(\tan x)-\tan(\sin x)}{x^7}.$$

Solution by Hugo Brandt, Chicago

Method 1. Call the fraction V and apply the L'Hospital rule seven times, the limit of $-(1/30)$ is found. The enormous amount of work involved is not shown.

Method 2. Using the series

$$\sin n=n-\frac{n^3}{3!}+\frac{n^5}{5!}-\frac{n^7}{7!}+\cdots$$

and

$$\tan m=m+\frac{m^3}{3}+\frac{2m^5}{15}+\frac{17m^7}{315}+\cdots$$

and putting $n=\tan x$, and $m=\sin x$, then neglecting all powers higher than the seventh power, we get

$$\sin(\tan x)=\left[x+\frac{x^3}{3}+\frac{2x^5}{15}+\frac{17x^7}{315}\cdots\right]-\frac{1}{3!}\left[x+\frac{x^3}{3}+\frac{2x^5}{15}\right]^3$$

$$+\frac{1}{5!}\left[x+\frac{x^3}{3}\right]^5-\frac{x^7}{7!}+\cdots$$

$$\sin(\tan x)=\left[x+\frac{x^3}{3}+\frac{2x^5}{15}+\frac{17x^7}{315}-\frac{3^3}{3!}-\frac{3x^2}{3!}\cdot\frac{x^3}{3}\right]-\frac{3x^2}{3!}\cdot\frac{2x^5}{15}-\frac{3x}{3!}\left(\frac{x^3}{3}\right)^2 \tag{1}$$

$$+\left[\frac{x^5}{5!}-\frac{x^7}{7!}\right]+\frac{5x^4}{5!}\cdot\frac{x^3}{3}+\cdots$$

$$\tan(\sin x)=\left[x-\frac{x^3}{3!}+\frac{x^5}{5!}-\frac{x^7}{7!}\right]+\frac{1}{3}\left[x-\frac{x^3}{3!}+\frac{x^5}{5!}\right]^3+\frac{2}{15}\left[x-\frac{x^3}{3!}\right]^5+\frac{17x^7}{315}+\cdots$$

$$\tan(\sin x)=\left[x-\frac{x^3}{3!}+\frac{x^5}{5!}-\frac{x^7}{7!}+\frac{x^3}{3}-\frac{3x^2}{3}\cdot\frac{x^3}{3!}\right]+\frac{3}{3}\,x^2\cdot\frac{x^5}{5!}+\frac{3}{3}\,x\left[\frac{x^3}{3!}\right]^2 \tag{2}$$

$$+\left[\frac{2}{15}x^5+\frac{17x^7}{315}\right]-\frac{2}{15}\cdot 5x^4\cdot\frac{x^3}{3!}+\cdots.$$

Now the items in the 2 brackets are the same in (1) and (2), and cancel in the expression $\sin(\tan x)-\tan(\sin x)$; there remains

$$\sin(\tan x)-\tan(\sin x)=\frac{x^7}{360}(-12)$$

$$\therefore\quad \frac{\sin(\tan x)-\tan(\sin x)}{x^7}=-\frac{1}{30}+xM,$$

where xM represents the quotient of the neglected powers divided by x^7, which becomes 0, $x\to 0$.

Other solutions with different results were given by James Dodd, Northwestern University and Julian H. Braun, Washington, D. C.

2307. *Proposed by Hugo Brandt, Chicago.*

If a three digit number: u, unit's digit; t, ten's digit; and h, hundred's digit, equals the same number with another base, say n, but with the order of digits reversed, find all possible cases.

The Proposer's Solution

The problem is equivalent to finding integer: for n, u, t, h to satisfy the equation

$$100h+10t+u=n^2u+nt+h. \tag{1}$$

Case A. For $n<10$, this equation may be written

$$99h+(10-n)t=(n^2-1)u. \tag{2}$$

For $n=9$, we have

$$99h+t=80u$$

$$110h+(t-h)=80u$$

$\therefore t-h$ is a multiple of 10, only possible if $t=h$. Then

$$100h=80u \qquad \therefore\quad u=5,\ h=4,\ t=4.$$

Hence

$$\underline{544_9=445}$$

Search for cases for $n<9$ proves fruitless.

Case B. For $n>10$ equation (2) becomes

$$99h-(n-10)t=(n^2-1)u. \tag{3}$$

For $n=11, 12, 15, 17, 18, 20, 22$ there are no results. We investigate the remaining cases.

$n=13$

$$99h-3t=168u$$
$$33h-t=56u$$
$$32h+(h-t)=56u$$

$h-t$ is, then, a multiple of 8, only possible if $h=t$.
Then:

$$32h=56u; \qquad u=4,\ h=7,\ t=7.$$

Hence

$$477_{13}=774$$

$n=14$

$$99h-4t=195u.$$

$\therefore t$ is a multiple of 3, say $3m$

$$33h-4m=65u$$
$$33h+(u-4m)=66u$$

$u-4m$ is, then, a multiple of 33, only possible if $u=4m$.
When $33h=66u$; $2u=h=8m$, only possible if $m=1$, $h=8$, $u=4$, $t=3$.
Hence

$$\underline{438}_{14}=\underline{834}$$

A similar study for $n=16, 19, 21, 22$ and 28 gives results as tabulated below.
Résumé:

n	9	13	14	16	19	19	21	21	22	28
In notation with base n	544	477	438	173	144	288	155	219	115	169
In decimal notation	445	774	834	371	441	882	551	912	511	961

Solutions were also offered by C. W. Trigg, A. R. Haynes, Tacoma, Wash.

2308. *Proposed by Hugo Brandt, Chicago.*

For a given parabola, $y^2=2px$, P is a variable point with PQ and PS as tangents. If triangle PQS is constant in area show that the locus of P is another parabola, same form, same parameter and same x-axis. Q and S are points of tangency.

Solution by C. W. Trigg, Los Angeles City College

The line $y=mx+b$ is tangent to $y^2=2px$ when the discriminant of $m^2x^2+2(mb-p)x+b^2=0$ vanishes. That is, when $b=p/2m$. Hence, $y=mx+p/2m$ is tangent to $y^2=2px$ at $x=p/2m^2$, $y=p/m$. If the tangent line passes through $P(X, Y)$ we have $Y=mX+p/2m$, so

$$m=[Y\pm\sqrt{Y^2-2pX}]/2x \tag{1}$$

gives the slopes of the two tangents from P.
Now if the area of PQS is to be constant, then

$$\frac{1}{2}\begin{vmatrix} X & Y & 1 \\ p/2m_1^2 & p/m_1 & 1 \\ p/2m_2^2 & p/m_2 & 1 \end{vmatrix} = c, \text{ a constant.}$$

Or,

$$\rho X\left(\frac{1}{m_1}-\frac{1}{m_2}\right)-\rho Y(1/m_1^2-1/m_2^2)/2+\rho^2(1/m_1-1/m_2)/2m_1m_2=2c.$$

Simplifying,

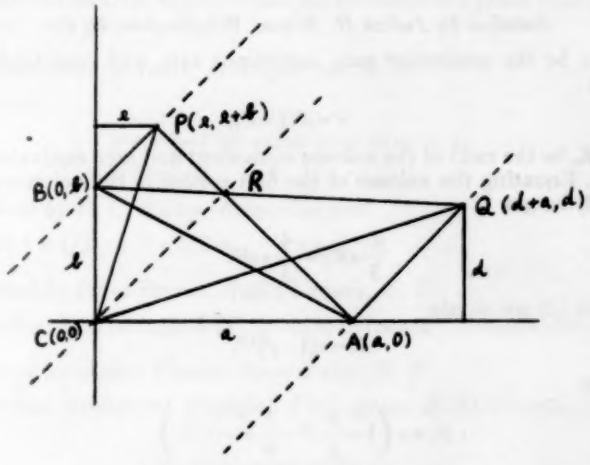
$$X-Y(m_2+m_1)/2m_1m_2+\rho/2m_1m_2=k, \text{ a constant.} \tag{2}$$

From (1) we have $m_2+m_1=Y/X$ and $m_1m_2=p/2X$. Whereupon (2) becomes $Y^2=2pX-pk$.

Solutions were also offered by: Leon Bankoff, Los Angeles; A. R. Haynes, Tacoma, Wash.; and the proposer.

2309. *Proposed by C. W. Trigg, Los Angeles City College*

Similar triangles are constructed on the legs of a right triangle with their third vertices lying on the lines through the vertices of the acute angles of the right triangle and parallel to the bisector of the right angle. Show that the joins of these third vertices to the remote vertices of the right triangle intersect on the bisector of the right angle.



Solution by Aaron Buchman, Buffalo

Let the dimensions and position be those used in the diagram. From the relation between the alitudes of similar triangles, it follows that

$$ae=bd. \tag{1}$$

Now the equation of AP is

$$\frac{x-a}{y}=\frac{e-a}{e+b}$$

or

$$(e+b)x-(e-a)y=a(e+b). \tag{2}$$

And the equation of BQ is

$$\frac{x}{y-b}=\frac{d+a}{d-b}$$

or

$$(d-b)x-(d+a)y=-b(d+a). \tag{3}$$

Then the equation of the locus of R, the intersection of AP and BQ, may be found by adding (2) to (3), thus

$$(e+d)x-(e+d)y=ae-bd. \tag{4}$$

Using (1) to simplify (4) leads to

$$x=y.$$

Therefore, the locus of R, the point of intersection of AP and BQ, is the bisector of angle BCA.

Solutions were also offered by: Hugo Brandt, Chicago; A. R. Haynes, Tacoma, Wash.; C. W. Trigg, Los Angeles City College; Julian H. Braun, Washington, D. C.; Richard C. Roth, Oxford, Ohio; Leon Bankoff, Los Angeles; Richard H. Bates, Milford, N. Y.

2310. *Proposed by C. W. Trigg, Los Angeles City College.*

Show that the difference in the radii of the two spheres, one equivalent in area, the other equivalent in volume, to a *prolate* ellipsoid of revolution is of the fourth order in the eccentricity of the generating ellipse.

Solution by Julian H. Braun, Washington, D. C.

Let a, b, e be the semimajor axis, semiminor axis, and eccentricity, respectively. Then

$$b^2=a^2(1-e^2).$$

Let R_v and R_s be the radii of the volume equivalent and area equivalent spheres, respectively. Equating the volume of the first sphere to the volume of the prolate ellipsoid, we get

$$\frac{4}{3}\pi R_v^3=\frac{4}{3}\pi ab^2. \tag{2}$$

From (1) and (2) we obtain

$$R_v=a(1-e^2)^{1/3}, \tag{3}$$

or expanding,

$$R_v=a\left(1-\frac{1}{3}e^2-\frac{1}{9}e^4-\cdots\right). \tag{4}$$

Equating the area of the other sphere to the area of the prolate ellipsoid, we get

$$4\pi R_s^2=2\pi b^2+2\pi(ab/e)\arcsin e. \tag{5}$$

From (1) and (5) we obtain

$$R_s=a\left[\frac{1}{2}(1-e^2)+\sqrt{1-e^2}(e^{-1}\arcsin e)\right]^{1/2}. \tag{6}$$

Expanding (6) yields:

$$\begin{aligned} R_s&=a\left[\frac{1}{2}(1-e^2)+\left(1-\frac{1}{2}e^2-\frac{1}{8}e^4-\cdots\right)\left(1+\frac{1}{6}e^2+\frac{3}{40}e^4+\cdots\right)\right]^{1/2},\\ &=a\left(1-\frac{2}{3}e^2-\frac{2}{15}e^4-\cdots\right)^{1/2}\\ &=a\left(1-\frac{1}{3}e^2-\frac{11}{90}e^4-\cdots\right). \end{aligned} \tag{7}$$

Comparing (7) with (4) we see that the difference between R_v and R_s is of the fourth order in e.

A similar solution was also offered by the proposer.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

PROBLEMS FOR SOLUTION

2323. *Proposed by C. W. Trigg, Los Angeles City College* (a challenge to high school pupils).

From a right circular cylinder, radius R and length h, there is turned a symmetrical spindle composed of two truncated cones, joined at their small bases, which have a radius r. Find the ratio of the volume of the spindle and the cylinder in its simplest form, and determine its minimum value.

2324. *Proposed by Jefferson Hurst, Warren, Pa.*

Use the indirect method to prove that the altitudes of a plane triangle are concurrent in only one point.

2325. *Proposed by John Smith, McDuffietown, N. Y.*

Solve this set:

$$x^2+y^{1/2}=7 \text{ for values other than } (4, 1)$$
$$x^{1/2}+y^2=3.$$

2326. *Proposed by V. C. Bailey, Evansville, Ind.*

Prove that $1+1/3-1/5-1/7+\cdots=\pi/2\sqrt{2}$.

2327. *Proposed by Edna Barrett, Hall's Corners, N. Y.*

Construct the plane triangle ABC, given hypotenuse c, the area, and $\angle A-\angle B$.

2328. *Proposed by Gladys Platner, Stony Point, N. Y.*

Construct the equilateral triangle, ABC, given R its circum-circle radius.

BOOKS AND PAMPHLETS RECEIVED

MATHEMATICAL MODELS, by H. Martyn Cundy, *Sixth Form Mathematical Master, Sherborne School*, and A. P. Rollett, *Formerly Senior Mathematical Master, Sevenoaks School*. Cloth. 240 pages. 13.5×21.5 cm. 1952. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y., Price $4.25.

INTRODUCTION TO CONCEPTS AND THEORIES IN PHYSICAL SCIENCE, by Gerald Holton, Ph.D., *Assistant Professor of Physics and of General Education in the Physical Sciences, Harvard University*. Cloth. Pages xviii+650. 14×21.5 cm. 1952. Addison-Wesley Press, Inc., Kendall Square, Cambridge 42, Mass. Price $6.50.

PRACTICAL AND EXPERIMENTAL GEOGRAPHY, by W. G. V. Balchin, Ph.D., *Lecturer in Geography, King's College, University of London*, and A. W. Richards, M.A., *Senior Geography Master, The Grammar School, Farnborough, Hants*. Cloth. Pages viii+136. 16×21 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $2.75.

QUANTITATIVE CHEMICAL ANALYSIS, Tenth Edition, by Leicester F. Hamilton, S.B., *Professor of Analytical Chemistry, Massachusetts Institute of Technology*, and Stephen G. Simpson, Ph.D., *Associate Professor of Analytical Chemistry, Massachusetts Institute of Technology*. Cloth. Pages xvii+529. 13.5×21 cm. 1952. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $4.50.

MENTAL PRODIGIES, by Fred Barlow. Cloth. 256 pages. 12.5×18.5 cm. 1952. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $4.75.

GEOGRAPHY OF LIVING THINGS, by M. S. Anderson, M.A. Cloth. Pages ix +202. 12×18.5 cm. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $2.75.

YOUR TELEPHONE AND HOW IT WORKS, by Herman and Nina Schneider. Cloth. 96 pages. 13.5×20.5 cm. 1952. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. Price $2.00.

THORNDIKE-BARNHART HIGH SCHOOL DICTIONARY. Cloth. Pages xxiv+1096. 17×24 cm. 1952. Scott, Foresman and Company, 433 East Erie Street, Chicago 11, Ill. Price $4.00. (thumb-indexed, $4.40).

SEMIMICRO LABORATORY EXERCISES IN GENERAL CHEMISTRY, Second Edition, by J. Austin Burrows, Ph.D., *Professor Emeritus of Chemistry;* Paul Arthur, Ph.D., *Professor of Chemistry;* and Otto M. Smith, Ph.D., *Professor Emeritus of Chemistry and Director, Research Foundation, Oklahoma Agricultural and Mechanical College*. Paper. Pages xvii+302. 20.5×28 cm. 1952. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.50.

TV TROUBLESHOOTING AND REPAIR GUIDE BOOK, Volume I, by Robert G. Middleton. Paper. 204 pages. 20×28 cm. 1952. John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $3.90.

FREE AND INEXPENSIVE LEARNING MATERIALS. Paper. Pages viii+194. 13.5 ×21.5 cm. 1952. Division of Surveys and Field Services, George Peabody College for Teachers, Nashville, Tenn. Pricd $1.00.

ARTICLES ON THE HISTORY OF MATHEMATICS: A BIBLIOGRAPH OF ARTICLES APPEARING IN FIVE PERIODICALS, by Cecil B. Read, *Professor of Mathematics, University of Wichita, Wichita, Kansas*. University Studies, No. 26, 1952. Paper. 32 pages. 14×21.5 cm. Copies may be Obtained from the University of Wichita. Price of Fifty Cents for Single Copy, Additional Copies 25 cents.

PRECISION, A MEASURE OF PROGRESS. Paper. 63 pages. 13.5×21 cm. 1952. General Motors, Department of Public Relations, Detroit 2, Michigan.

SARGENT GUIDE TO PRIVATE JUNIOR COLLEGES AND SPECIALIZED SCHOOLS AND COLLEGES. First Edition, Paper. Pages 250. 12×18.5 cm. 1952. Porter Sargent, 11 Beacon St., Boston 8, Mass. Price $1.10.

THE SARGENT GUIDE TO SUMMER CAMPS FOR BOYS AND GIRLS. Seventh Edition. Paper. 86 pages. 12×18.5 cm. 1952. Porter Sargent, 11 Beacon St., Boston 8, Mass. Price $1.10.

Adhesive that joins rubber tiles to concrete can be used on concrete slabs flush with the ground, When it gets wet, the adhesive will not "let go" of the rubber tile.

To travel hopefully is a better thing than to arrive, and the true success is to labor.—R. L. Stevenson, *El Dorado*.

BOOK REVIEWS

THORNDIKE-BARNHART HIGH SCHOOL DICTIONARY. Cloth. Pages xxiv+1096. 17×24 cm. 1952. Scott, Foresman and Company, 433 East Erie Street, Chicago 11, Ill. Price $4.00 (thumb-indexed, $4.40).

This is a dictionary which will really help the student. It not only gives the definition, pronunciation, part of speech, and derivation, but often uses the word in a simple sentence. The first definition is the one most frequently used; then follow other less frequently used meanings. Not only are all the common words of the high school literature given but many of the abbreviations, biographical names, geographical places, and foreign terms found in the student's subjects of study. Suppose we look over page 124. This starts with "Bryce Canyon National Park, national park in S Utah. 55 sq. mi." Farther down we find the abbreviation, B.S. with its meaning. The word buck is given in four sections; first as a noun, then as a verb, then two additional uses as a noun as in *pass the buck* and U. S. slang for dollar. This page also contains four pictures to illustrate the meanings given; e.g. a bucking bronco, a buckboard, soldiers with bucklers, and a man using a bucksaw. This last illustration was no doubt made by one who never uses a bucksaw. The definition used is correct, but the illustration is very bad because, by holding the saw as shown, the man would accomplish practically nothing but would fall, completely exhausted, before finishing one cut. This illustration is taken from a page of the dictionary ads as well as from the book. On this advertising page they say: "Pictures—accurate, interesting, and lifelike . . . ." Too bad! The wrong page was selected. We examined many pages and did not find another with such an illustration. The print is large and clear; the abbreviations used are few but important. A sample definition will show many of the important characteristics.

> **ad mi ra tion** (ad′mə rā′shən), *n.* **1.** a feeling of wonder, pleasure, and approval. **2.** act of regarding with delight (something fine or beautiful): *They paused in admiration of the beautiful view.* **3.** person or thing that is admired (now used only in the phrase *the admiration of*).

Note the use of the schwa (ə) to denote the vowel sound most commonly heard in unaccented syllables. At the bottom of each left hand page are two lines which trace the origin and history of words, and on the right hand page is a short pronunciation key. On the inside cover and fly leaf, both front and rear, are an etymology key, a list of language abbreviations used, and a complete pronunciation key. No more valuable book can be purchased for your high school boy or girl than a copy of this Dictionary.

G. W. W.

ZOOLOGY IN POSTAGE STAMPS, by W. Dennis Way, Editor, *Stamp Collectors' Fortnightly*, 1941–50, and O. D. Standen, M.Sc., *Fellow of the Zoological Society*. Cloth. Pages vii+113. 17.5×24 cm. 1952. The Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y. Price $5.00.

This is a book to interest both the student of natural history and the philatelist. Before 1900 very few stamps in this field had appeared, but soon after the opening of the present century many foreign countries began to illustrate their stamps with animal pictures peculiarly their own. Many of these are excellent illustrations; some were issued in commemoration of a particular event and in very limited numbers; a few were of inferior design. Thirty-two full page plates in black and white show samples of the stamps. An attempt has been made to classify tha animals starting with the mammals and going down the list of vertebrates, birds, reptiles, amphibians and fishes, then the invertebrates, arthropods and molluscs. Each subdivision is briefly described, then followed by a sentence or two on the stamps which illustrate, giving the country, year, and

original value. A philatelic index and a zoological index complete the book. An excellent gift book.

G. W. W.

THE LOST PHARAOHS, THE ROMANCE OF EGYPTIAN ARCHAEOLOGY, by Leonard Cottrell. Cloth. 256 pages. 13.5×21.5 cm. 1951. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

For those who want to learn a little about the ancient Egyptians this book was written. Only a few years ago practically nothing was known about the people who built the great pyramids and the thousands of smaller structures, many completely buried in the sands of the desert. Now by the work of Professor Breasted, P. E. Newberry, Sir Alan Gardiner, Howard Carter, Lord Carnarvon, and many others, much of the history of this famous land has become known. Excavation and study has revealed much about the life, occupations, pleasures, wars, arts and culture of the Egyptians five thousand years ago. The brief story of how all this was found out, the struggles of the scientists, the delays caused by lack of funds, wars, and governmental hindrances are told in a marvelous manner. The great discovery of the tomb of Tutankhamen is the climax. These pages alone are worth several times the price of the book. But in addition you have a short account of all other excavations, many excellent pictures and a brief list of important references.

G. W. W.

THE CHEMISTRY OF ORGANIC COMPOUNDS by James B. Conant, *President of Harvard University* and Albert H. Blatt, *Professor of Chemistry, Queens College.* Cloth. Pages VIII+655. 15 by 23.5 cm. Fourth Edition, 1952. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.90.

This is the fourth revision of an organic textbook which was first published in 1933. During the years it has been widely used. Many present-day leaders in the field of chemistry studied their first organic chemistry from a Conant text.

The book starts as the other editions have, with the chemistry of alcohols rather than hydrocarbons. The general order of topics is similar to previous editions. The first twenty chapters treat mainly the aliphatics; while the aromatic, alicyclic, and heterocyclic compounds are treated in the latter part of the book. One whole chapter is devoted to biochemistry. Many industrial applications are emphasized. Chapter five has the title "Gasoline and Rubber" and treats both classical and recent development in these fields.

A reasonable amount of space has been devoted to the mechanisms of certain organic reactions and the directions which the reactions may take. In the preface the authors state, "Experience in the classroom has shown that there is a rather sharp limit to the amount of material of these latter two sorts that can be profitably included in the first year's work in chemistry."

Teachers who have successfully used the previous editions of this textbook will be well-pleased with this recent revision. The reviewer considers it to be an excellent first book in Organic Chemistry.

GERALD OSBORN
Western Michigan College of Education
Kalamazoo, Michigan

PRINCIPLES OF CHEMISTRY, Sixth Edition, by Joel A. Hildebrand and Richard E. Powel, *both are professors at the University of California.* Cloth. Pages XII+444. 13.5 by 12.5 cm. 1952. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $4.50.

Since this book is the sixth edition of a wellknown text, it does not require a lengthy review. The authors atate in the preface: "This revision has been made in order to maintain the practice of thirty-four years, first of incorporating improvements in presentation evolving from the experience, year after

year, of an exceptionally competent group of instructors, and second, to keep the book abreast of such advances in chemistry as even freshmen can appreciate, and this do some justice to the exciting, dynamic character of this great field of knowledge." They further emphasize that this is not a major revision such as was true with the fifth edition. The main revisions are "found in the chapters dealing with the structure of matter, the properties of atoms, chemical binding, chemical kinetics, equilibrium, and oxidations."

As in the past, the book is properly named; emphasis is placed on chemical principles rather than descriptive material. In many text books quite a number of chapters are devoted to the various families of the elements. This is not true in this book. In chapter seventeen, "The Periodic System of Elements," the various families and their general family properties are given, but lengthy details giving properties of each element are omitted. Such an approach has the advantage of placing emphasis on the thinking process rather on the memorizing of many minute details. For the more descriptive information there is available a companion book, *Reference Book of Inorganic Chemistry*, by Wendell M. Latimer and Joel H. Hildebrand. Professor Latimer is also located at the University of California.

GERALD OSBORN

CHEMICAL CALCULATIONS, AN INTRODUCTION TO THE USE OF MATHEMATICS IN CHEMISTRY by Sidney W. Benson, *Professor of Chemistry, University of Southern California.* Cloth. Pages XI+217. 14.5 by 22.5 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $2.95.

This book is designed to aid the many students who have trouble with the mathematical problems of General College Chemistry. Each type of problem is illustrated by a solved example. At the end of each chapter a goodly number of unsolved problems are there for student practice. A table of answers is found in the appendix. The topics treated include: measurement, chemical formulae, chemical reactions, energy and chemical change, properties of gases, valence, solution concentrations, physical properties of solutions, chemical equilibrium, properties of ionic solutions, hydrolysis, oxidation and reduction, and rates of chemical reaction. In the solving of gas law problems only the formula method is given. Some teachers prefer the fractional or sometimes called "common sense" method of solving these problems.

Since such topics as buffer mixtures, solubility products, and oxidations and reduction are treated so thoroughly, second year chemistry students will find the book helpful for their work in analytical chemistry. First year students using this book should really get a hold of the chemistry and be able to think mathematically as chemists think. College teachers of chemistry should welcome this book as a real aid in teaching. The book should be acceptable for class use or as a self-help reference for students having trouble with the language of chemistry.

GERALD OSBORN

HIGH SCHOOL BIOLOGY, by Charlotte L. Grant, *Oak Park and River Forest High School, Oak Park, Illinois;* H. Keith Cady, *Oak Park and River Forest High School, Oak Park, Illinois;* and Nathan A. Neal, *Formerly Public Schools, Cleveland, Ohio.* Cloth. Pages ix plus 813. 15×23.5 cm. Second Edition, 1952. McGraw-Hill Book Company, New York. Price $3.88.

Here is a high school biology book so complete in its coverage of the subject that it is like all others under one cover. Its massiveness might, at first, cause a student to rebel at the thought of becoming responsible for knowing its contents, but students soon become, I am sure, absorbed in this skillfully written text. One of its outstanding and eye-appealing features are the full-page illustrations which introduce each unit with a dramatic impact. These were specially done for this text by Miss Berenice Abbott. The book is equally well illustrated throughout, however, with numerous photographs and diagrams, all carefully

selected to convey their message clearly. The text material itself is up-to-date in every respect, and the study of biology is woven about the ecological balance of the earth. It points out the synonymy of wildlife conservation—the conservation of all our natural resources—and human conservation, a concept not often presented so ably to imaginative and impressionable minds.

High School Biology is a different kind of biology text. Its organization departs from the standard approach, and the result is a highly practical, commendable addition to classroom texts.

GEORGE S. FICHTER
Oxford, Ohio

UNDERSTANDING HEREDITY—AN INTRODUCTION TO GENETICS, by Richard B. Goldschmidt, *University of California.* Cloth. Pages ix plus 228. 14×21 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New Uork, N. Y. Price $3.75.

In recent years there has been a tremendous upsurge in the amount of interest in genetics by both students of science and layman. This, as might be expected, resulted in the publication of many articles and books on the subject to fit the various levels of study and attention. The tendency has been to produce books which are either very elementary and popularized or highly technical. There has been nothing for those in-between students, those who want more than a smattering of knowledge about genetics but who do not plan making genetics—or biology, for that matter—their specialty. This book answers that specific need. It is short and easy to read; it covers the basic facts accurately and with adequate detail; it was written by one of the world's outstanding authorities on the science of genetics. This book is definitely inthe "must" category for all teachers of biology and for all reference shelves. It answers those often asked questions about *what is* and *what is not* inherited; furthermore, it explains *how.*

GEORGE S. FICHTER

FUNDAMENTALS OF HEALTH AND SAFETY, by Grover W. Mueller, *Teachers College, Temple University;* and Elizabeth Chant Robertson, *Department of Paediatrics, University of Toronto.* Cloth. 345 pages. 15×22.5 cm. Second Edition, 1952. D. Van Nostrand Company, Inc. Price $2.80.

This, the second edition of a book first released in 1948, should be called to the attention of high school teachers primarily to let them know it is once again available in quantities. The book's value is already appreciated by those who have used it. The theme of the book is wise self-management through intelligent, authoritative health information, greatly needed by our youth today to combat the "plethora of free advice, propaganda, advertisements, cures, fads, and isms which constantly assail them through the newspapers, magazines, radio, theater, motion pictures—and word of mouth." The book discusses the various body systems, explains their functioning and how to maintain their action in proper and productive balance. There are also chapters on alcohol, drugs, accident prevention, major diseases threatening national health, public health services, etc.; and there are text illustrations, questions to answer, supplementary class projects, and a comprehensive glossary. This is a book worth examination for text usage.

GEORGE S. FICHTER

THE MOLDS AND MAN, AN INTRODUCTION TO THE FUNGI, by Clyde M. Christensen, Professor of Plant Pathology. *University of Minnesota.* Cloth. Pages viii+244. 14×22 cm. 1951. University of Minnesota Press, Minneapolis 14, Minn. Price. $4.00.

Prior to the discovery of penicillin very few authors had attempted to present the interesting aspects of the fungi to the biology student or the interested layman. Now, and with good reason, this vast assemblage of plants is claiming

more and more attention and interest. The author in his prefatory note mentions that the study of the fungi has been an absorbing stimulating adventure for him. His manner of handling a subject which to many persons would be considered "dry" is indeed commendable. Consider the challenge offered to an interested youth by the discussion of morels and their culture. "The one who does cultivate them will have a gold mine and one that can be exploited for a long time. There is money in morels. But grow them first." Dr. Christensen, then goes on humbly to suggest that some amateur may stumble upon the secret, whereas specialists have failed completely.

This book consists of ten timely, well-chosen chapters, an appendix on fungi classification, an excellent index, and illustrations. It is unfortunate that a text of this type could not have been enriched with numerous photographs. This reviewer wonders how far the author's tongue was in his cheek when he inserted the sketch of the coincidental, humanoid, young mycelium on page 10.

The Molds and Man is such a rich, timely, source of information that it should be made available in the libraries of our high schools and cities as well as in the science departments of colleges and certain industries.

JOSEPH P. MCMENAMIN

BASIC HORTICULTURE, Revised Edition, by Victor R. Gardner, *Formerly Horticulturist and Director of the Agricultural Experiment Station, Michigan State College, East Lansing, Michigan.* Cloth. Pages x+465. 15×23.5 cm. 1951. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $4.75.

Those interested in horticulture textbooks will need no introduction to this revised edition. The author has tried to make the text even more useful and adaptable through the suggestions and criticisms of associates and others who have used the book.

There are twenty-three chapters giving a broad and extensive range of material, an index, a ten-page glossary (which students and instructors appreciate in a specialized subject), a short section listing twenty-four general questions and problems, and four pages given to suggested laboratory exercises. The author has presented 185 excellent photographic illustrations, many emphasizing contrasting features stressed in the text. The chapters are well organized and subdivided into short sections with large topic headings. Each chapter closes with a series of problem questions which can be of much value to student and instructor in evaluating grasp of the material.

High school biology teachers will find this text of useful reference source in answering those practical questions that often arise from the observations of the thoughtful student.

JOSEPH P. MCMENAMIN

TEACHING MATHEMATICS IN THE SECONDARY SCHOOL, by Lucien Blair Kinney, *Professor of Education, Stanford University;* and C. Richard Purdy, *Associate Professor of Mathematics, San Jose State College.* Cloth. Pages xvi+381. 15×23 cm. 1952. Rinehart and Company, Inc., 232 Madison Avenue, New York 16, N. Y. Price $5.00.

Although this book may find its greatest sale as a textbook for prospective teachers of mathematics, this if true is unfortunate. Not only is it a gold mine of information for the prospective teacher—it should be available to every teacher of mathematics, irrespective of the years of experience.

There are many excellent features; in particular the reviewer would call attention to the first three chapters, dealing with mathematics in modern life; the historical background of the mathematics curriculum; and present day problems of curriculum and instruction. Again, each chapter contains a well selected bibliography (ranging from thirteen to forty items for each chapter). There are suggested lists of questions and exercises which offer many distinct challenges to the reader.

The book has chapters on the teaching of algebra; geometry; advanced algebra, trigonometry, and solid geometry; junior college mathematics (brief, but very well done); general mathematics (four chapters). The chapter on constructing and using tests is very good indeed.

The reviewer was especially pleased with the treatment of such topics as division by zero (p. 148); the use of the blackboard (pp. 294–5); the use of fallacies (p. 182 and elsewhere). The chapter on recreational mathematics offers very distinct possibilities for increasing interest in mathematical thinking. At many places there are historical notes which should prove of great value. In many places the authors refer to presentations by teachers who are obviously masters. Some are unknown to this reviewer, others are personally known as fine craftsmen; whether real or fictitious the presentations offer many valuable suggestions.

Perhaps one might wonder if everything is good about this text. There are a few minor points of criticism. The paper is thin, and at times material on the other side of the page shows through, making the text hard to read. On page 45 and again on page 86 the use of dates AD and BC is suggested as a means of presentation of positive and negative numbers—possibly a bad choice, since there is no year numbered zero. On page 122, in discussing the Königsberg bridge problem, the impression is given that a proof has been presented, yet it is doubtful that a rigorous demonstration of an "impossibility proof" is given here. These points are, however, relatively minor, and do not detract from the general value of the book.

CECIL B. READ
University of Wichita

THE ELEMENTS OF MATHEMATICAL ANALYSIS, Vols. I and II, Second Edition, by J. H. Michell, M. A., F. R. S., *Formerly Fellow of Trinity College, Cambridge and Professor of Mathematics, the University of Melbourne;* and M. H. Belz, M. Sc., M. A., *Associate Professor of Mathematical Statistics, the University of Melbourne.* Cloth. 1087 pages. 14×22 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $13.60 the set.

This two volume work is a British publication, covering, in considerably greater detail and with greater rigor than found in many American texts, the content of differential (Volume I) and integral calculus (Volume II) including a treatment of differential equations more extensive than found in most of our introductory calculus texts. The work does contain more detailed explanations than are found in many British texts, which may in part account for its bulk. There is a large supply of problems, with a rather wide range of difficulty, at the end of each chapter; no answers are provided.

As might be expected, at many points the vocabulary and the notation seem strange, for example: simplex numbers (real numbers); the range (a, b) indicating the inclusion of b but the exclusion of a; one-way continuous functions; dimetric functions; upper and lower derivatives; point of contraflexure (point of inflection); intermediate first derivative theorem (mean value theorem); factor integration (integration by parts). The first chapter, entitled "Elementary properties of functions" is much more advanced than normally be found in the first part of an American text (as an example, in discussing infinite sequences the authors present Kummer's, Raabe's, and D'Alembert's test for convergence).

There is a considerable body of material not found in the usual first text in differential and integral calculus. As illustrations of such topics, one might mention the discussion of the slope of a tangent in oblique coordinates; line coordinates; a rather extensive discussion of the use of various tables of numerical values and the accuracy of interpolation (no mention is made of the excellent tables prepared in the United States during the days of the WPA and later); the reason for the factor one-half in the definitions of the hyperbolic sine and cosine; epicene and expocyclic functions; numerical integration; curve fitting by the method of moments, the method of least squares, and the use of zonal harmonics; a chapter on our number system.

It is very doubtful that this work will be suitable for a text in most universities. It would not be classified, on the other hand, as an advanced reference work. Perhaps its greatest value would be as an excellent supplementary reference work for the private or school library. In many places it would provide a more rigorous treatment or an extension of the discussion in the usual beginning calculus text book, for reference either by the student or the teacher (experienced or beginner alike). To illustrate in a single instance, one might mention the unusual sequence of first developing the formula for the derivative of a reciprocal, then considering the derivative of a quotient as the derivative product of two functions, one of which is a reciprocal. From the point of view of a supplementary reference work, which covers much additional material, frequently giving a rigorous presentation on a level which can be followed, yet using methods which will later be needed to read advanced treatises, this work is well worth its cost.

CECIL B. READ

CONTRIBUTIONS TO THE FOUNDING OF THE THEORY OF TRANSFINITE NUMBERS, by Georg Cantor. Translated and Provided with an Introduction and Notes by Philip E. B. Jourdain. Paper. Pages vii+211. 12.5×20.5 cm. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.25.

This is one of the special paper bound editions of certain titles of this publisher. At the very low price, it becomes possible to obtain works hitherto unavailable because of the expense involved.

As might well be expected, a considerable amount of mathematical maturity is needed to follow the material of this book; however, the material is so basic in certain parts of modern mathematics that the student finds it essential to have it available. Perhaps as valuable as the articles by Cantor is the eighty-two page introduction by Jourdain, which is not only historically important, but also leads the student through a considerable portion of the background needed to follow the balance of the book.

Although the general content is indicated by the title, mention of a few topics considered by Cantor may give a clue to the type of material covered; the concept of "power"; greater and less; the smallest transfinite cardinal number; simply-ordered aggregates; well-ordered aggregates; numbers of the second number class; the second greatest transfinite cardinal number.

Although the book is available in a clothbound edition for more permanent reference, it would seem the publishers have done a distinct service to issue certain titles in these cheaper editions.

CECIL B. READ

RADIO AND TELEVISION RECEIVER CIRCUITY AND OPERATION, by Alfred A. Ghirardi, Author of Radio Physics Course, Modern Radio Servicing, etc. and J. Richard Johnson, Co-author, Practical Television Servicing. Cloth. Pages xvi+669. 17.5×25 cm. 1951. Rinehart Books, Inc. 232 Madison Avenue, New York 16, N. Y. Price $6.00.

Those already familiar with the Ghirardi books will be pleased to hear that a new series is in the making. A. A. Ghirardi's *Radio Physics Course*, *Modern Radio Servicing*, and *Radio Trouble-shooter's Handbook* are familiar manuals to the radio service technician, the student and the radio experimenter as a valuable source of practical information on all phases of radio theory, construction and service. These books have not lost their importance, but are somewhat incomplete due to the rapid advance in the past few years in the field of FM radio, TV, home recorders and high fidelity sound systems.

Rather than add to the already complete library of books referred to, a completely new series of books to comprise a Modern Radio and Television Servicing Library is being edited and published. The present book is the first in this new series to be published. The complete series to be completed this year will be:

Radio and Television Receiver Circuity and Operation

Radio and Television Troubleshooting, Repair and Installation Test Instruments

This first volume provides complete information for the radio technician on modern circuits and systems covering the latest developments in circuits, antennas, materials of construction, principles of operation and explanations of AM, FM and TV as well as covering modern recorders, record changers and new magnetic recording devices. Of necessity, in order to give complete coverage of the subject, basic background information is given in summary form followed by detailed explanations of improvements and modifications as they have occurred in recent years.

Written for the radio service technician and the radio experimenter, the treatment of subject matter is nonmathematical and stresses in simple terms the practical aspect of the subject. A very detailed index gives ready reference for wanted information.

Written for the student, the chapters are treated as separate units, topics being numbered within the unit. A special feature is a summary at the end of each chapter followed by review questions to check understandings of the principles within the unit chapters. Answers to the odd-numbered questions are given in the back of the book for self-check. Also included is a glossary of terms to give immediate clarification of frequently used words and expressions. The general format of the printed matter along with very thoroughly explained diagrams makes the book a textbook for the uninitiated and a ready reference work for the technician seeking to add to his knowledge or refresh his memory.

With the addition of the second and third publications featuring troubleshooting methods and test instruments necessary for modern radio and TV servicing work, the Modern Radio and Television Library will be a complete and up-to-date reference work.

O. F. WARNING
Lyons Township H. S.
LaGrange, Illinois

TV AND ELECTRONICS AS A CAREER, by Ira Kamen, *Brach Mfg. Corp.* and Richard N. Dorf, *TV Consultant.* Cloth. Pages x+326. 16×24 cm. 1951. John F. Rider Publisher, Inc. 480 Canal Street, New York 13, N. Y. Price $4.95.

Within the last few years the entire field of electronics, particularly television, has opened new vistas in the way of job opportunities for those otherwise interested in the technical and operating aspects of radio. In television especially, careers that never existed before are being demanded by the industry faster than they can be acknowledged or publicized.

This book is expressly written to acquaint young people and even men and women with these expanding fields: radio and television broadcasting; communications; manufacturing; engineering; distribution and sales; radio and TV servicing. In non-technical language, the authors describe the detailed workings of each phase of separate industries, followed by the complete story of how each man (or woman) contributes to the over-all job operation, how much he is paid, how he gets the job, what training is needed, and what the future outlook is. Without losing its glamor, each occupation is described in terms of the person actually performing the specific duties assigned. The reader is made to feel that he is actually present and performing in the actual operation, giving a true on-the-job experience in each career.

Besides the careers usually open to public view, the lesser recognized but more frequently entered careers in manufacturing, engineering, servicing, distribution and direct sales are described. In fact, the major contribution of the book is to describe impartially the many opportunities open for the individual to fit himself into this ever growing field.

A separate chapter, "Electronics In the Armed Forces" is of guidance to young

people who wish to gain valuable experience in and through the armed forces.

To conclude the book, short biographies of some outstanding men now in electronics and TV are cited as examples of the careers available in this open door field.

O. F. WARNING

PASTEUR'S STUDY OF FERMENTATION. Edited by James Bryant Conant. Paper. Pages 57. 15.5×23 cm. 1952. Harvard University Press, Cambridge.

This pamphlet is number six in a series of "Case Histories in Experimental Science." Editor Conant says, "(their) purpose . . . (is) to assist the student in recapturing the experience of those who once participated in exciting events in scientific history . . . (so that) the methods . . . employed (may) stand out clearly." From such a vivid introduction it is assumed that the reader may be impelled to continue his interest in science "throughout his life."

This, Case 6, opens the field of biochemistry and bacteriology, cases one to four dealt with the physical sciences. The Foreword, by the editor, carries subtitles: Understanding Science; Use of Case Histories; Methods of Science; Advance of Science and Progress in the Practical Arts; and Pure and Applied Science. This foreword is the same for all cases so far published.

The new material in the booklet is sectioned into: General Introduction (briefing the plan of presentation); Some Elementary Principles of Biochemistry (needed "if a study of this case is to prove rewarding"); Pasteur's Work on Optical Activity which Resulted in His Study of Fermentation; Translation of Portions of Pasteur's Memoir on Lactic Fermentation (which is really the core section of this case history) and a concluding interpretative section achieved by selected paragraphs from John Tyndall's lecture on "Fermentation and Its Bearings on Surgery and Medicine." Pasteur's memoir was first presented in 1857; Tyndall's lecture is dated 1876 so represents an evaluation of Pasteur's paper in perspective.

This case history is the briefest of any so far released but rates, in the judgment of this reviewer, one of the best of the five he has read. It is direct in presentation, concise and stimulating in style. While there are some paragraphs of Tyndall's reprint that are repetitious, in general there is very little dead timber in its pages.

B. CLIFFORD HENDRICKS,
Longview, Washington

SECONDARY SCIENCE EDUCATION, by Harrington Wells, *Associate Professor of Science Education, University of California, Santa Barbara College.* Cloth. Pages xi+367. 16×24 cm. 1952. First Edition, McGraw-Hill Book Company Inc., New York. Price $4.50.

This is one of about five dozen books in the McGraw-Hill series on education. The author has previously prepared a volume of the series, Elementary Science Education. The book under review "completes the survey of science education as a specialized field below the college level."

The preface promises an "intercorrelation between the science fields" and "a sponsorship of functional community-industry correlation with the science in the secondary school." The "science-social science interdependence" is especially to be stressed.

Part one of the book has to do with the "philosophy of approach, methods of procedure and suggested subject content." Part two lists resource aids; audio-visual materials; industry's pamphlets, pictures and posters and commercial sources of equipment and supplies.

Bibliographies of subject matter content and teaching methodology are extensive but patchy. Such noted authors as Edgar Dale, in Audio-visual aids; H. G. Deming, in the chemistry text book field, and R. W. Tyler, in the field of evaluation, to mention only a few, find no place in these bibliographies. The

well known *Journal of Chemical Education* is not included in "Magazines useful in secondary science education."

For those who would expect explicit help in class room and laboratory practice this book will prove disappointing. The author says, "there is less need for a professional recipe book detailing manipulative techniques than there is for an applied philosophy in terms of an interpretative survey of principles and trends."

B. CLIFFORD HENDRICKS

THE SLUMBERING PERCH

The discovery that perch spend the night asleep on the bottom near shore after making their daily migrations from deep water was revealed today to the biologists attending the 15th annual meeting of the American Society of Limnologists and Oceanographers by scientists from the University of Wisconsin.

The scientists, Arthur D. Hasler, James R. Villemonte, Lester V. Whitney, and Richard Dugdale, studied the movements of schools of perch in Lake Mendota, bordering the Wisconsin campus, while adapting marine echo-sounding gear to shallow-water research projects.

By using an echo-sounder mounted on a 40-foot navy launch, both of which have been loaned to the Wisconsin Lake Laboratory for navy-sponsored research, it is possible to pick up and trace the movements of schools of perch, in addition to obtaining information on the size and depth of the school, Prof. Hasler said in speaking for the research team.

During most of the work the scientists have checked the echo-sounder's oscilloscope recordings against actual observations by divers to learn exactly what each oscilloscope pattern means in terms of the events going on under water. During such an observation at night it was discovered that perch have the habit —a peculiar one for fish—of settling to the bottom and resting motionless throughout the night.

During the daylight hours the perch move in large schools which hover at depths ranging between 25 and 35 feet below the surface. As the light becomes dim toward sundown they move toward shore until they encounter the bottom. Then the school disperses and each fish quietly sinks to the sand and becomes motionless shortly after dark.

It was this habit of quietly blending into the bottom that aroused the scientists' curiosity—because on the echo-sounding oscilloscope it looked as though the perch disappeared. A diver sent below at night with a flashlight found thousands of perch on the bottom. When they were disturbed by the flashlight they would move just out of the brightest beam and sink again to the bottom.

Although perch have a strong schooling instinct during daylight, Prof. Hasler said, they seem to lose it at night when they can no longer see one another.

Pre-drawn observations show that the perch remain in the same spot throughout the night. At daybreak they rise from the bottom and congregate into schools. Shortly after sunrise they move back into deeper water.

In parts of the lake that are shallow, the perch have no need to migrate shoreward at night, Hasler said, and the fish in shallow-water schools simply sink to the bottom when it gets dark.

Fishing rod made of stainless steel is small enough to be carried in the pocket of a sport jacket. Measuring only 16½ inches from tip to handle, the rod has a sort of pistol-like grip, and has ¼-inch holes perforated in the handle. A slot directly under the reel can be used as a bottle opener.

Aluminum storm window that doubles as a window screen in the summer is quickly installed even on out-of-true windows and requires no protruding tacks or channels. Its screen or storm sash can be stored in the upper part of the window when not in use.